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Studies on the zeolites. Part IX. Scolecite and metascolecite.[1]

(With Plates VIII and IX.)

By Max H. Hey, M.A., B.Sc.
With X-ray measurements by F. A. Bannister, M.A.
Assistant-Keepers in the Mineral Department of the British Museum of Natural History.

[Read January 24, 1935.]

SCOLECITE was recognized as an independent species by A. F. Gehlen and J. N. Fuchs[2] (1813), being one of the species into which they divided, on chemical grounds, the mesotype of R. J. Haüy (1801). Its individuality has rarely been doubted, though occasionally the union of natrolite, mesolite, and scolecite into one isomorphous group has been proposed.

[1] Parts I–VIII, Min. Mag., 1930–5, vols. 22–24.

[2] These authors spelt the name 'Scolezit'; the spelling 'scolecite' appears to be due to J. D. Dana (Syst. Min., 1st edit., 1837, p. 271). The spelling 'Skolezit' appears to have originated with K. C. von Leonhard (Handb. Orykt., Heidelberg, 1821, p. 454). G. Delafosse (Cours de Min., Paris, 1862, vol. 3, p. 334) and A. Des Cloizeaux (1862) spell the name 'scolésite'. C. Hintze (Handb. Min., Leipzig, 1889–97, vol. 2, p. 1698) uses the spelling 'Skolecit'. A. Dufrénoy (Traité de Min., Paris, 1847, vol. 3, p. 428) incorrectly derives the name from σχολης, cheveux'; Gehlen and Fuchs definitely state that the name was given 'weil sich die nadelformigen Krystalle dieses Fossils wurmformig krümmen' when heated, so that the derivation must be either from σκώληξ, a worm (as is usually stated), or, as suggested by W. X. F. von Kobell (Mineral-Namen, München, 1853, p. 87), from σκολιάζω, to be crooked.

Three varieties of scolecite have been described, but all have prove to be other minerals. Thus poonahlite (H. J. Brooke, 1831; = mesc lite) was long included with scolecite. Lehuntite (T. Thomsor 1836; = natrolite) was classed as a soda-scolecite by A. Kenngot (1850) solely on account of its high water content. And a miner from Pargas, Finland, was described by N. Nordenskiöld (1821) a anhydrous scolecite (wasserfreies Scolezit); this was copied by W Phillips (1823) as 'scolecite', and this incorrect copy appears to b the authority for the citation of Pargas as a scolecite locality b Dana and others. There is no evidence that scolecite occurs a Pargas, and, according to M. L. Frankenheim (1842) and F. J. Wi (1871), the material examined by Nordenskiöld was really a plagi clase. It may be noted that the locality 'Auvergne' cited by Dar and others for scolecite is also incorrect and is due to an error in paper on an Auvergne natrolite by J. Guillemin (1826).

Chemical composition, unit-cell formula, and specific gravity.

Scolecite usually occurs fairly well crystallized, and free fro admixture with other zeolites, hence most of the analyses in th literature[1] agree in suggesting the formula $CaAl_2Si_3O_{10}.3H_2O$, althoug only fourteen have been made on material for which there is ar optical evidence of purity.

Two new analyses have been made on material the purity of whi was optically checked, and are given in table I. The atomic rati

TABLE I. New chemical analyses of scolecite. (Localities, see table II.)

	SiO_2.	Al_2O_3.	CaO.	SrO.	BaO.	Na_2O.	K_2O.	H_2O.	Tot
1.	45·16	25·90	14·86	nil	nil	0·16	0·06	13·66	99·
2.	45·36	26·49	15·01	nil	nil	0·06	0·03	13·40	100·

per 80 oxygen atoms, the oxygen atoms per unit cell, specific gra ties, and some other physical data are given in table II for the tw new analyses and for the fourteen from the literature for which the is some definite evidence of purity. The oxygen content, in ato per unit cell, was calculated as usual from the analyses, speci

[1] In all, 56 analyses were collected, of which 27 were accounted first class, second class, 12 third class, and 5 rejected as useless. The total alkalis w determined and reported as Na_2O in 16 of the first-class analyses, while soda a potash were separated in only 8; for the second-class analyses the correspondi figures are 6 and 1, and for the third-class 8 and 2.

ravities, and the cell size, and shown to be 80 within the limits of robable error.

TABLE II. New analyses of scolecite and analyses from the literature of material of tested purity. Expressed as atomic ratios per 80 oxygen.

		1.	2.	3.	4.	5.	6.	7.	8.
80 oxygen.	Si	23·73	23·63	24·32	24·02	23·98	24·23	23·94	24·29
	Al	16·04	16·23	15·73	16·34	16·06	15·52	16·11	15·86
	Ca	8·36*	8·36*	7·22	8·14	7·94	7·98†	7·91	7·63
	Na	0·16	0·06	1·06	0·15	—	0·00	0·12	—
	K	0·03	0·02	0·09	—	—	0·02	—	—
	H_2O ...	23·94	23·23	28·88‡	22·80	24·39	24·40	23·55	23·65
	Si+Al ...	39·77	39·86	40·05	40·36	40·04	39·75	40·05	40·15
lass of analysis ...		A	A	A	B	B	B	A	A
xygen atoms per unit cell ...		80·20	80·43	—	81·52	—	—	81·19	—
xygen %		40·62	40·79	40·35	41·06	40·38	40·69	40·89	41·18
p. gr.		2·276§	2·273§	—	2·289	—	—	2·289	—

		9.	10.	11.	12.	13.	14.	15.	16.
80 oxygen.	Si	23·89	24·04	24·03	23·86	23·55	23·25	23·92	24·15
	Al	16·14	16·09	16·09	16·09	16·51	16·38	15·90	15·84
	Ca	7·63	7·78	7·78	8·14	8·13	7·61	8·00	7·58
	Na_2O ...	0·36	—	—	—	—	0·66	0·51	0·64
	K_2O ...	0·04	—	—	—	—	0·12	0·07	0·09
	H_2O ...	23·39	25·30	24·36	23·87	23·86	23·44	25·27	24·04
	Si+Al ...	40·03	40·13	40·12	39·95	40·06	39·63	39·82	39·99
lass of analysis ...		A	A	A	A	A	C	A	A
xygen atoms per unit cell ...		78·75	79·56	79·42	—	—	—	80·58	79·56
xygen %		40·31	40·55	40·33	40·80	40·73	40·96	40·92	40·76
p. gr.		2·252	2·262	2·270	—	—	—	2·27	2·25

* Ba and Sr tested for and found absent.

† Also 0·25 atom Mg.

‡ By difference; probably high.

§ Probable error ±0·005; $D_{4^\circ}^{20^\circ}$ corrected to vacuum.

1. B.M. 33887, Syhadree Mts., Bombay, India.
2. B.M. 95304, Berufjord, Iceland.
3. W. F. Hillebrand, 1885. Table Mtn., Golden, Colorado, U.S.A.
4. G. Tschermak, 1905. Poonah, Bombay, India.
5. O. B. Bøggild (N. V. Ussing, analyst), 1905. Karsuanguitkakait, Greenland.
6. W. F. P. M'Lintock (E. G. Radley, analyst), 1915. An Gearna, Ben More, Mull, Scotland.
7. G. Tschermak, 1917. Poonah, Bombay, India.
8. G. Stoklossa, 1918. Iceland. (Mean of two analyses.)
9. T. L. Walker and A. L. Parsons (E. W. Todd, analyst), 1922. Digby Gut, Annapolis Co., Nova Scotia.

10 and 11. A. Bianchi and A. Cavinato, 1925. Miage, Mt. Blanc, Piedmont, Italy.

12. A. Cavinato, 1927. Teigarhorn, Berufjord, Iceland.
13. A. Cavinato, 1927. Maderanerthal, Switzerland.
14 and 15. V. Gennaro, 1929. Valle di Viù, Valle di Lanzo, Piedmont, Italy.
16. V. Gennaro, 1929. Bettolina, Valle di Ayas, Mt. Rosa, Piedmont, Italy.

Optical data are given in the literature for the material of analyses 5, 11, 12 and 15, crystallographic data for nos. 11 and 15, and dehydration data for nos. 8 9, 11, 12, and 13. Correlated data are also available for several of the less reliable analyses.

The unit-cell formula is therefore $Ca_8Al_{16}Si_{24}O_{80}.24H_2O$. The Si : Al ratio is very constant, there being no evidence of any replacement of Si by Al or vice versa. But there is a certain degree of replacement of Ca by the alkalis (Na and K), though it is much less than the replacement of Na_2 by Ca in natrolite; as may be seen from table II, this can reach to about 1 atom Na and 0·1 atom K per unit cell, though, of course, these figures cannot be regarded as a definite maximum. Higher alkali contents have been recorded (T. Thomson 1840; P. Collier, 1868; J. Lemberg, 1877; L. Darapsky, 1888), but there is no proof of the purity of the material analysed.

There is no adequate evidence as to whether or no scolecites ever carry appreciable amounts of Ba or Sr. They were tested for and found absent in the two new analyses, but there is no evidence that they have ever been looked for before. Figures for the water content range from 21·6 to 25·3 mols. H_2O per unit cell, but some of the lower ones were probably obtained with material dried at 100° C. taken in conjunction with the vapour pressure data, the evidence is fairly conclusive that the water content is 24 mols. per unit cell at saturation.

Data for the specific gravity of scolecite show a considerable range, both in the specific gravity found and in the probable accuracy of the result. The mean of seventeen of the most reliable determinations from the literature (eight were rejected), ranging from 2·246 to 2·31, is 2·272, while the two new determinations on the analysed specimens gave 2·273 and 2·276. The influence of the small amount of alkali often present must be negligible, and the most probable value for the specific gravity of fully hydrated scolecite is $D_4^{20°} = 2·274$ corrected to vacuum.

Crystallography, pyroelectricity, and X-ray measurements.

The monoclinic symmetry of scolecite and its invariable twinning on $a(100)$ were first observed by Sir David Brewster (quoted by W. Haidinger, 1825). True untwinned scolecite crystals probably

lo not exist, but it is not uncommon for large crystals to have both
(111) and $e(\bar{1}11)$ well developed on both individuals of the twin;
n such cases there is frequently a deep notch between the two indi-
iduals, and it is not difficult to break off the upper ends to give
pparently single crystals.

Ten crystals were examined goniometrically, with the results shown
n table III. Each face $o(111)$ or $e(\bar{1}11)$ was found to be replaced

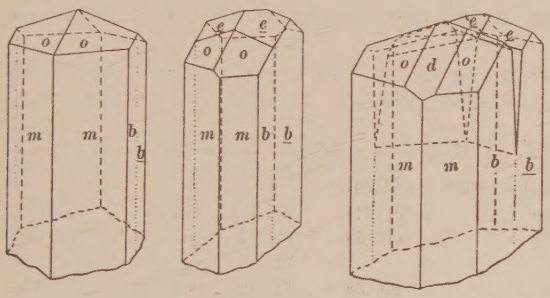

FIG. 1. Twinned crystals of scolecite.

y a vicinal pyramid; usually this is three faced, but occasionally
ne face may be suppressed, and often only one face is accurately
easurable. The face $d(101)$ sometimes gives good reflections, but
often slightly curved in the zone $ad[010]$ over a range of 10′ to
0′. The face $R(\bar{1}01)$ was observed, very small, on two crystals
rom Berufjord, Iceland (B.M. 1914,1195 b and c); this appears to
e a new form for scolecite. The prism $m(110)$ is often present
lmost exactly in true position, but may be replaced by a four-faced
icinal pyramid, of which one face (which may be on either side of
he true position, but is generally truly in the zone [001]) is generally
uch larger than the others. On one crystal (B.M. 1914,1195 b)
symmetrical etch-pits were observed on $m(110)$, bounded by planes
nclined at 0° 10′ to 0° 40′ to [001] and 1° to 5° to $m(110)$. On
everal crystals narrow facets of $k(120)$, $l(210)$, $H(340)$, $K(530)$, and
(520) were observed; the last three appear to be new forms, but
nly the first of them was of any appreciable size, the other two
eing extremely narrow.

The goniometric data gave the elements $a:b:c = 0{\cdot}9759:1:0{\cdot}3432$,
$= 89° 15′$, in excellent agreement with the values deduced from
he X-ray work, $0{\cdot}975:1:0{\cdot}345$, $\beta = 89° 21′$, and with the litera-
ure values. Probably the elements deduced by G. Flink (1888),

$a:b:c = 0{\cdot}9764:1:0{\cdot}3434$, $\beta = 89° 18'$, are the most accurate; these differ only very slightly from the values obtained by V. von Zepharovich (1884) and by G. Kalb (1932), but the X-ray results suggest that they are nearest the truth.

TABLE III. Goniometric data for scolecite. $a:b:c = 0{\cdot}9759:1:0{\cdot}3432$, $\beta = 89° 15'$.*

Interfacial angles $b(010):F(hkl)$:—

Form.	$m(110)$.	$k(120)$.	$H(340)$.	$l(210)$.	$K(530)$.	$L(520)$.	$d(101)$.	$R(\bar{1}01)$.	$o(111)$.	$e(\bar{1}11)$.
Obs.†	44° 18′	62° 49′	52° 35′	25° 40′	30½°	22°	90° 7′	89° 57′	72° 9′	71° 57′
			52 23	26 10				90		
Calc.	44 18‡	62 53	52 27	26 1	30° 21′	21° 19′	90 0	90 0	72 8	72 0

Interzonal angles $ab[001]:bF[\bar{1}0h]$:—

Form	...	...	$d(101)$.	$R(\bar{1}01)$.	$o(111)$.	$e(\bar{1}11)$.
Obs.†	...	...	69° 56′	71° 42′	69° 58′	71° 20′
				71 3		
Calc.	...	...	69 58	71 18	69 58	71 18

* These elements are calculated from the observations cited by the method of weighted means; but it is probable that the elements found by G. Flink (1888) are more accurate.

† These values are means except for *H*, *l*, *K*, *L*, and *R*, for which all the measured values are given.

‡ Half the measured cleavage angle; this was used as a fundamental value in the calculation of the elements.

Parallel growths and intimate intergrowths of scolecite with natrolite and with mesolite have already been described in connexion with the latter minerals (Min. Mag., **23**–254, 429).

The piezoelectricity of scolecite has been in some doubt, contradictory reports being given by S. B. Elings and P. Terpstra (1928), M. von Laue (1926), and G. Greenwood and D. Tomboulian (1932). Prof. Terpstra kindly undertook a re-examination of the matter, using crystals from the analysed specimen no. 1 (B.M. 33887), and states that there can be no doubt that scolecite is piezoelectric, though occasionally crystal aggregates will fail to show any effect in the piezoelectric oscillator; he hopes to report more fully on these anomalies shortly.

J. N. Fuchs (1816) observed that scolecite is very strongly pyroelectric, and this observation has been repeatedly confirmed. The analysed specimens showed the property very well, and the crystals were attached by the analogous pole, as appears to be invariably the

ase. The distribution of the pyroelectric charge indicates that colecite belongs to the planosymmetric class S, a conclusion which supported by the artificial etch-figures observed by F. Rinne (1894) nd the natural etch-figures described above. Several crystals which ad been etched with dilute nitric acid, as described by Rinne,[1] are ncluded in the Trechmann collection, presented to the British Iuseum by Dr. C. T. Trechmann in 1926, and the figures correspond xactly to Rinne's description and drawings.

The X-ray study fully confirmed these conclusions as to the ymmetry of scolecite, the space-group being clearly shown by the alvings to be S^4. There is, however, a very close approximation o the orthorhombic C_{2v}^{19}, and most of the diffractions which should e halved for that space-group are very weak, and some not detectbie. Rotation photographs of scolecite (pl. IX, fig. 3) are very imilar to those of natrolite (pl. IX, fig. 4), and there can be no oubt that these zeolites are isostructural, but the scolecite photoraphs show a number of extra lines, partly owing to the appreciable eparture of β from 90°. Lauegrams (pl. VIII, fig. 1) confirmed the nonoclinic symmetry. By taking a Lauegram of a very thin twinned eedle along the b-axis and measuring the separation of several pairs f spots produced by the two members of the twin, β was estimated s 89° 23½′ (this procedure, which does not seem to have been escribed before, allows of a very accurate estimation of β when uitably twinned crystals are available). By a comparison of the pacings of the (18.2.2) and (18.2.$\bar{2}$) planes and of the (12.2.2) and 12.2.$\bar{2}$) planes, using oscillation photographs, another determination f β was made, and the value 89° 18′ obtained. Mean $\beta = 89° 21' \pm 5'$. he other dimensions of the unit cell were found to be: a 18·48 ± 0·04, 18·95 ± 0·04, c 6·54 ± 0·02 Å.

As with mesolite, it was desirable to be able to use the X-ray hotographs as a means of deciding whether a given base-exchange roduct is, or is not, a scolecite. A list of the diffractions which ay be observed near the centre of a rotation photograph of mesolite bout the axis of elongation, in addition to the natrolite diffractions, as already been given (Min. Mag., **23**–430); with scolecite the ifferences from the natrolite photograph are much fewer. Using e-K radiation[2] there is an additional diffraction due to (042) at

[1] These crystals (B.M. 1926,1835) were etched by the late Dr. C. O. Trechann in 1894, a few months after Rinne's results were published.

[2] The data previously given for mesolite refer to Cu-K radiation.

ξ 0·41 on the second layer-line, while the diffraction at ξ 0·29 is doubled, (222) and ($\bar{2}22$), and on the first layer-line a triple spot at ξ 0·73 replaces the double spot in natrolite. These are the only differences of diagnostic value for base-exchange products, for which mere intensity differences are in general valueless. The most noticeable intensity difference is much stronger (331) at ξ 0·43.

Optics.

A detailed optical study has been made of one of the analysed specimens (no. 1, B.M. 33887), while many other specimens have been examined shortly. No appreciable variation in the optical properties has ever been recorded, so that it did not appear worth while repeating the detailed examination on several specimens. The measurements were made on cut plates and prisms, corrections being made where necessary for mal-orientation of the sections, and all the results were checked against one another to assist in determining their probable accuracy. Direct measurements were made of α, β, and γ, $\gamma-\beta$, $2V$, and the angle $\alpha : c$ [001], and are given in tables IV to VII and fig. 2.

TABLE IV. Refractive indices of scolecite (B.M. 33887) for various wavelengths. Observed values only, probable accuracy varies from ±0·0007 to ±0·0022. For dispersion equations, giving refractive indices with an estimated accuracy of ±0·0001, see text.

λ, Å.	α.	β.	γ.	λ, Å.	α.	β.	γ.
7200 ...	1·5087	—	1·5167	5350 ...	1·5162	1·5233	1·5227
6910 ...	1·5082	—	1·5164		1·5150		1·5237
6708 ...	1·5096	1·5162	1·5175		1·5150		
	1·5095			5250 ...	1·5159	—	1·5238
6563 ...	1·5096	1·5173	1·5171	5000 ...	1·5187	1·5256	1·5246
	1·5108				1·5167		
6500 ...	1·5106	—	1·5191	4930 ...	1·5186	—	1·5251
6250 ...	1·5113	1·5179	1·5193	4916 ...	1·5191	1·5262	—
	1·5114			4861 ...	1·5180	—	1·5255
6070 ...	1·5129	—	1·5204	4830 ...	1·5188	—	1·5266
5893 ...	1·5125	1·5200	1·5205	4590 ...	1·5214	—	1·5291
	1·5133			4550 ...	1·5205	1·5295	1·5284
5850 ...	1·5118	—	1·5202		1·5224		
5708 ...	1·5137	1·5208	—	4358 ...	1·5230	—	1·5309
5690 ...	1·5125	—	1·5209	4200 ...	1·5242	—	1·5326
5550 ...	1·5146	—	1·5230	4100 ...	1·5263	—	1·5338
5461 ...	1·5156	1·5224	1·5217				
	1·5138						

From these measurements dispersion equations were calculated, and it was found that the following expressions give values agreeing

with the measurements within the estimated probable accuracy of the latter; the estimated probable accuracy of the values computed from the equations is given in each case (λ in Å.).

$$\gamma - \beta = 0{\cdot}000701 - 3{\cdot}3 \times 10^3/\lambda^2 + 1{\cdot}2 \times 10^{11}/\lambda^4 \pm 0{\cdot}000005,$$
$$\gamma - \alpha = 0{\cdot}01039 - 1{\cdot}64 \times 10^5/\lambda^2 + 2{\cdot}4 \times 10^{12}/\lambda^4 \pm 0{\cdot}00010,$$
$$\gamma = 1{\cdot}5105 + 2{\cdot}8 \times 10^5/\lambda^2 + 2{\cdot}0 \times 10^{12}/\lambda^4 \pm 0{\cdot}0001.$$

From these equations $2V$ can be calculated with a probable accuracy of $\pm 5'$, and a calculated curve is included in fig. 2 (p. 237).

TABLE V. Optic axial angles of scolecite (B.M. 33887) for several wavelengths. Estimated probable accuracy of these observed values, ± 10 to $20'$, of the calculated values, $\pm 5'$.

λ, Å	...	6708.	6150.	5893.	5630.	5260.	5170.	4861.	4780.	4502.
$2V$	Calc.	34° 6′	34° 51′	35° 16′	35° 38′	36° 11′	36° 20′	36° 46′	36° 54′	37° 5′
	Obs.	34 21	34 37	35 20	35 28	36 8	36 13	36 41	36 53	37 10
				35 12						
				35 18						

TABLE VI. Extinction-angle on $b(010)$, $\alpha : [ab]$, for scolecite (B.M. 33887); α lies in the obtuse angle β. 'Calculated' values from the smoothed curve, fig. 2. Estimated probable accuracy of the absolute values of the extinction-angle $\pm 20'$, of the horizontal dispersion, $\pm 5'$.

λ, Å	...	7000.	6708.	6250.	5893.	5461.	5350.	5000.	4861.
$\alpha : [ab]$	Calc.	16° 10′	16° 13′	16° 18′	16° 22′	16° 28′	16° 30′	16° 36′	16° 39′
	Obs.	16 10	16 8	16 18	16 22	16 29	16 30	16 37	16 35

O. Luedecke (1881), C. Schmidt (1886), G. Flink (1888), and A. Bianchi and A. Cavinato (1925) have observed some interesting optical anomalies in crystals of scolecite. Plates cut parallel to $a(100)$ are said to give sometimes distinctly oblique extinction, and plates cut parallel to $b(010)$ may give different extinction-angles in the two halves of the twin. Plates parallel to $c(001)$ show varying phenomena, from simple non-parallel extinction in the two halves of the twin to a division into four, or even eight, fields with different extinction-angles. Several explanations have been suggested for these observations, but it seems probable that the true explanation must be strain, as suggested by G. Flink (1888); the anomalies are too irregular and too variable to indicate anorthic symmetry (O. Luedecke, 1881). Plates cut approximately parallel to $c(001)$ were prepared from seven crystals from different localities.[1] None

[1] B.M. 43581, 47672, 47674, and 48234 from Syhadree Mts., Bombay; B.M. 35325 from Fellithal, Uri, and B.M. 60084 and 95305 from Berufjord, Iceland.

of these showed the major anomalies described, though one showed a slight difference in extinction-angle between the two halves of the twin (1–2°), which may be due to sub-parallel growth. Some tendency was noted for apparent field divisions to appear owing to light reflected from cleavage cracks, but in no case could the above anomalies be confirmed.

TABLE VII. Birefringence, $\gamma-\beta$, of scolecite (B.M. 33887), measured as extinctions in several orders on four different plates. Estimated probable accuracy $\pm 0{\cdot}000015$ to $0{\cdot}000040$. For dispersion equation, giving the birefringence with an estimated accuracy of $\pm 0{\cdot}000005$, see text.

λ, Å.	$\gamma-\beta$. Obs.	$\gamma-\beta$. Calc.	Order of interference.	Effective thickness of plate, mm.
6980	0·000590?	0·000684	2nd	2·37
6770	0·000693	0·000686	3rd	2·93
6600	0·000673	0·000688	3rd	2·94
6440	0·000680	0·000691	4th	3·79
5630	0·000713	0·000716	3rd	2·37
5510	0·000727	0·000723	5th	3·79
5440	0·000724	0·000727	4th	2·94
5150	0·000703	0·000747	4th	2·93
4910	0·000777	0·000770	6th	3·79
4770	0·000814	0·000788	5th	2·93
4680	0·000796	0·000800	5th	2·94
4670	0·000788	0·000801	4th	2·37
4470	0·000826	0·000837	7th	3·79
4300	0·000881	0·000874	6th	2·93

Base-exchange.

Coarsely powdered scolecite was treated with fusions of sodium chlorate, potassium thiocyanate, and of lithium, ammonium, silver, and thallous nitrates; the products were examined chemically and optically, and such as remained sufficiently coarsely crystalline were examined by X-ray methods. As explained above, it was readily possible to characterize the products as natrolites, mesolites, or scolecites by the presence or absence of certain diffractions on X-ray rotation photographs about the axis of elongation.

Lithium nitrate gave a product which was identified from its X-ray photograph as lithium-natrolite; its chemical composition and optical properties agree with this, and it appears to be essentially identical with the products obtained by the action of lithium nitrate on natrolite and mesolite, only differing in its small residual lime content.

Potassium thiocyanate gave a product in which some of the crystals, which had a very low birefringence, were zoned, many of them having a core which gave oblique extinction and had an optically negative elongation and an outer zone which gave straight

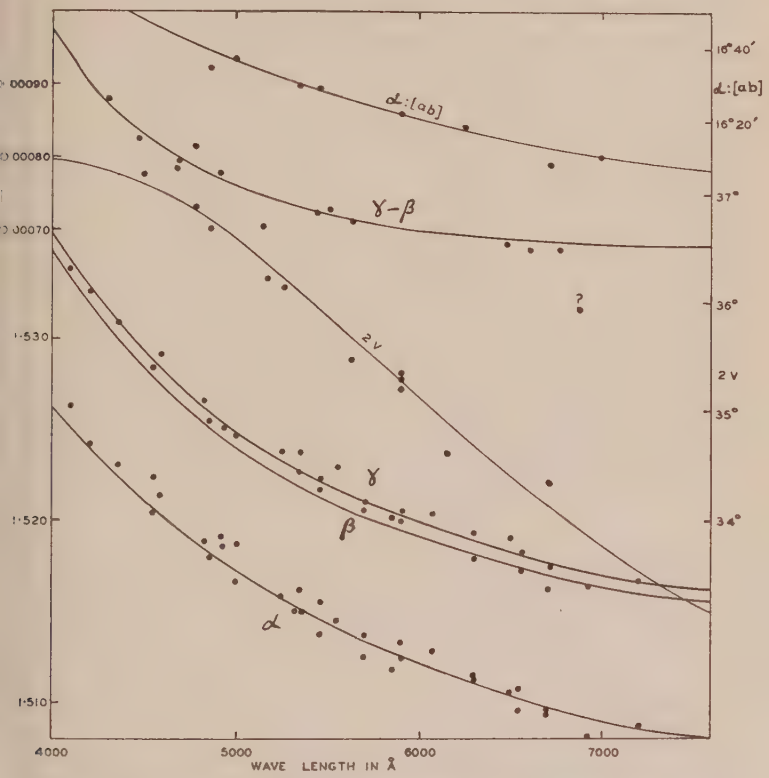

FIG. 2. The variation of the optical constants of scoleçite with the wave-length of the light.

extinction and positive elongation, as did the bulk of the smaller-grained material. There was no definite intermediate zone. The crystals were unfortunately not suitable for X-ray study. Their chemical composition and optical properties indicate that the inner zone is probably a potassiferous scolecite, while the outer zone is either a potassium-mesolite or, more probably, a potassium-natrolite. It was hoped that sodium chlorate would give rise to mesolite, but although the fusion did not last long, the product was found by optical and X-ray methods to be a natrolite; chemical analysis

showed it to contain a considerable proportion of lime, but not more than in some calciferous natrolites already known.

With the ammonium nitrate, base-exchange did not progress far,

TABLE VIII. Base-exchange data for scolecite.

		Untreated.	270° C. 70 hrs. $NaClO_3$. *	200° C. 48 hrs. KCNS. *	270° C. 70 hrs. $LiNO_3$. *	180° C. 48 hrs. NH_4NO_3.	270° C. 96 hrs. $AgNO_3$.	220° C. 48 hrs. $TlNO_3$.
Percentage composition.	SiO_2 ...	45·16	45·31	43·33	49·77	44·30	39·74	31·80
	Al_2O_3 ...	25·90	28·71	26·94	31·97	28·60	26·58	20·16
	CaO ...	14·86	5·38	5·84	0·64	14 30	9·89	6 89
	R_2O† ...	—	11·44	14·07	7·96	1·45‡	14·14	32·60
	H_2O ...	13·66	9·78	9·97	10·47	12·04‡	10·23	8·46
	Total ...	99·80§	100·62	100·15	100·81	100·69	100·58	99·91
Oxygen % ...		40·62	41·88	39·76	45·64	41·30	37·26	29·65
Oxygen atoms per unit cell		80·20	80·29	—	79·60	78·94	79·1‖	—
Atoms per 80 oxygen.	Si ...	23·73	22·9	23·2	23·2	22·9	22·6	22·9
	Al ...	16·04	17·1	17·0	17·5	17·3	17·8	17·1
	Ca ...	8·36¶	2·9	3·3	0·3	7·8	6·0	5·3
	R† ...	—	11·2	9·6	15·0	0·5	4·2	6·6
	H_2O ...	23·94	16·5	17·8	16·3	20·6	19·4	20·3
Sp. gr. ...		2·276	2·253	2·223	2·171	2·209	2·43 to 2·63	3·6

								Mixture	
Mean refractive index	1·517	1·484	1·500 ± ‡‡	1·500	1·517	1·525 ± to 1·54 ±	1·544 ††	1·53
Birefringence	0·008	0·01	0·005 ± ‡‡	0·01	0·01	0·01	small	
Optical sign of elongation	neg.	pos.	**	pos.	neg.	neg.	**	neg.
Extinction-angle on cleavage faces to elongation	—	0°	**	0°	12 to 13°	1 to 5°	0°	12°
Cell-sides in Å.	*a* ...	18·48	18·36	—	17·53	18·51	18·54	—	—
	b ...	18·95	18·71	—	18·70	18·90	18·99	—	—
	c ...	6·54	6·54	—	6·47	6·53	6·55	—	—
Interaxial angle β ...	89° 21′	90° 0′	—	90° 0′	89° 20′	≠90°	—	—

* These products are natrolites.

† R indicates the cation of the salt used in the base-exchange.

‡ The method used for the determination of NH_3 and H_2O was that described in part III of this series (Min. Mag., vol. 23, p. 278).

§ Includes 0·16 % Na_2O and 0·06 % K_2O.

‖ Taking the sp. gr. as 2·43.

¶ Also 0·16 atom Na and 0·03 atom K.

‡‡ Outer zone.

†† This product is either a mesolite or a natrolite.

** Zoned; see text.

and the oblique extinction, optically negative elongation, and high water content indicated scolecite with a slight substitution of calcium by ammonium; this the X-ray evidence confirmed.

Silver nitrate gave rise to an argentiferous scolecite, as evidenced by oblique extinction, negative elongation, and X-ray data. The proportion of silver ions which can replace calcium is remarkable considering that two silver atoms must replace one calcium, and is perhaps evidence of the correctness of W. H. Taylor's view (1933) that the extra eight water molecules of scolecite do not occupy the eight cavities left vacant when the sixteen sodium ions of natrolite are replaced by eight calcium ions. A vapour pressure study of an argentiferous scolecite would be particularly interesting, but neither time nor material permitted of it.

The product obtained with thallous nitrate was a mixture of two derivatives; one is clearly a thallous-scolecite, having a relatively low refractive index and oblique extinction, while the other, with straight extinction and a much higher refractive index, is probably a thallous-natrolite, but may be a thallous-mesolite. The latter crystals were zoned, the interior having an optically positive, the exterior an optically negative, elongation. This material was not suitable for X-ray study.

These base-exchange experiments clearly show that scolecite is isostructural with natrolite, and hence with mesolite also; the method used precluded any possibility of solution and recrystallization, and optical and X-ray evidence show that identical products can be prepared from scolecite and natrolite.

Vapour pressure.

New vapour pressure data obtained for scolecite (B.M. 33887) by the isohydric method have yielded results of considerable interest. Sixteen isohydric curves were worked out (table IX and fig. 3), and interpreted in the light of the kinetic theory of zeolitic vapour pressure equilibrium. The first five curves gave results in good agreement[1] with the equation:

$$\log p = S_0 + \tfrac{1}{2}\log T - \log x_s/(1-x_s) - 2\log\{1+\phi(x_s)\} - E/RT \,.\, \log_e 10$$

where p is the vapour pressure in mm.Hg, T the absolute temperature, and x_s the fraction of the more volatile group of sixteen water

[1] Good agreement could also be obtained with another interpretation, as far as these five curves are concerned, but it would then be impossible to explain the next three adequately.

molecules which have been removed), if the constants and unknown function $\phi(x_s)$ are taken as: S_0 9·28, E $2{\cdot}21 \times 10^4$ cals. per gram-mol. H_2O, and $\phi(x_s) = -0{\cdot}9x_s$. With these constants the equation gives an excellent representation of series 4 and 5, as will be seen by comparison of the observed and computed values of log p in table IX. For series 2 and 3 the agreement is not so good, but in these series the degree of dehydration was very small, and a slight error in the weighing of the vapour pressure apparatus would have a very serious effect on the computed pressure; if it is supposed that an error of 1·8 mg. was made in determining the water loss in series 3, and 0·8 mg. in series 2, good agreement results. In series 1 the degree of dehydration was so small that it is no longer possible to compare observed and computed pressures, and observed and computed degrees of dehydration are therefore shown in table IX instead; the observed values are calculated from the temperature, pressure, and known dead-space volume, assuming negligible dehydration at room-temperature; they are very approximate, but will be seen to be of the right order; the agreement would certainly be improved could allowance be made for the adsorption of water vapour by the glass walls of the bulb.

With series 6 a new phenomenon is observed; it is no longer possible to lay a single straight line through the experimental data when plotted in the form log p against $1/T$. And series 7 and 8 give decidedly less steep lines when so plotted than do series 2 to 5, and do not agree with the above equation even approximately. The interpretation of this result is definite and simple; scolecite undergoes a transition into a high-temperature form, presumably the metascolecite of F. Rinne (1890). While series 1 to 5 are due to scolecite, series 7 and 8 represent vapour pressures of metascolecite, and in series 6 the transition occurs within the range of the experimental data,[1] so that this series plots as two intersecting straight lines (fig. 3).

Before considering further the data obtained for metascolecite (which, as a distinct crystal phase, must rank as a definite species), it will be convenient to consider further the significance of the scolecite results. The heat of combination of the group of sixteen more volatile water molecules in scolecite, $Q = E + \frac{1}{2}RT$, is $2{\cdot}24 \times 10^4$ cals.

[1] It will be shown below that the transition temperature is actually within the temperature range of series 4, 5, 7, and 8 as well as series 6, but owing to the unavoidable experimental errors only the last shows the break clearly.

per gram-mol. of water at 20° C. This figure was roughly checked calorimetrically. Scolecite (2 grams), dehydrated to a loss of 0·0286 gram water, gave a temperature rise of 1·4° C. on hydration, the water equivalent being 11·58 grams. Hence the heat of hydration is found calorimetrically to be $2{\cdot}1 \times 10^4$ cals.

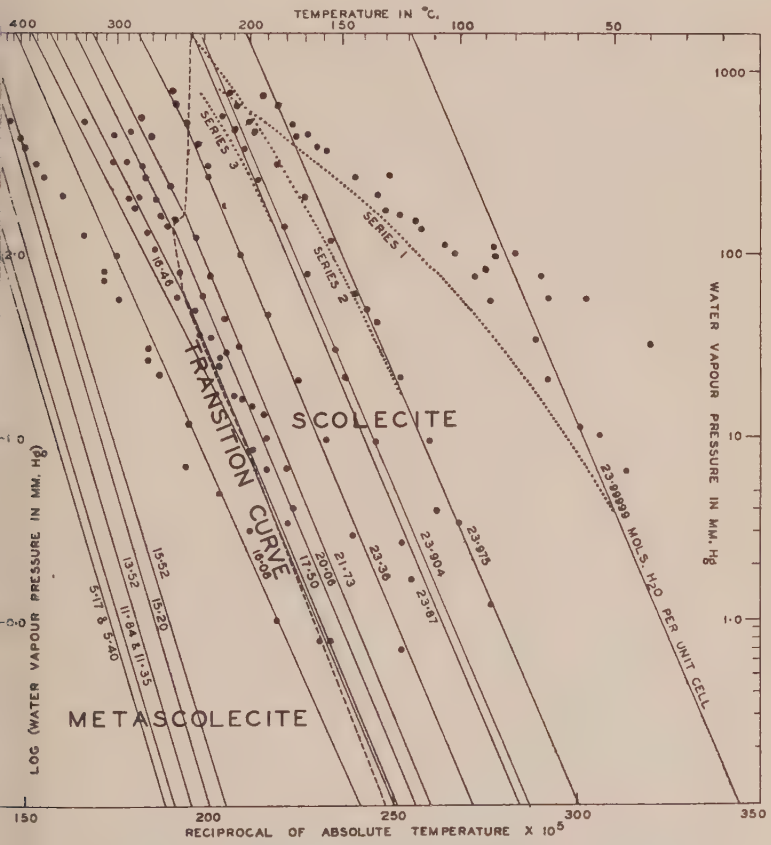

FIG. 3. Isohydric vapour pressure curves for scolecite and metascolecite. The curves are computed using the constants cited in the text, while the points show the experimental data.

Expanding the constant S_0 of the above equation and substituting the known data, the 'condensation area', a, is calculated to be $1{\cdot}6 \times 10^{-3}$ sq.Å., whence assuming 2·90 Å. as the diameter of the water molecule, the mean diameter of the water channels in scolecite is 2·94 Å.

The interpretation has required an assumption that sixteen of the water molecules in scolecite are more volatile than the other eight. While it would be possible to interpret series 2 to 5 on the assumption that the more volatile group is one of eight molecules, such an interpretation would lead to the conclusion that scolecite should be stable over a large part of the range, over which metascolecite is in fact observed; in other words, no reasonable interpretation of series 6, 7, and 8 could then be found.

TABLE IX. The water vapour pressure of scolecite and metascolecite at various temperatures and degrees of hydration, and the transition temperatures and three-phase equilibrium pressures at various degrees of hydration. c = water content in mols. per unit cell = $24-16x_s$ or $24-8x_m-16x_m'$. δc = dead-space loss, to be subtracted from c.

Series 1. Scolecite.
c 24·0 mols.

t° C.	log p.	log x_s obs.	log x_s calc.
48	0·81	$\bar{5}$·7	$\bar{6}$·7
55	1·00	$\bar{5}$·9	$\bar{6}$·9
60	1·05	$\bar{4}$·0	$\bar{5}$·1
70	1·32	$\bar{4}$·2	$\bar{5}$·2
74	1·53	$\bar{4}$·4	$\bar{5}$·2
90	1·75	$\bar{4}$·7	$\bar{5}$·6
96	1·88	$\bar{4}$·8	$\bar{5}$·7
102	2·00	$\bar{4}$·9	$\bar{5}$·8
71	1·76	$\bar{5}$·7	$\bar{6}$·7
91	1·91	$\bar{4}$·8	$\bar{5}$·4
107	2·05	$\bar{4}$·9	$\bar{5}$·9
116	2·14	$\bar{3}$·0	$\bar{4}$·1
124	2·22	$\bar{3}$·0	$\bar{4}$·3
135	2·33	$\bar{3}$·1	$\bar{4}$·5
144	2·42	$\bar{3}$·2	$\bar{4}$·7
159	2·56	$\bar{3}$·4	$\bar{3}$·0
168	2·65	$\bar{3}$·4	$\bar{3}$·1
177	2·70	$\bar{3}$·5	$\bar{3}$·2
188	2·82	$\bar{3}$·5	$\bar{3}$·4
193	2·87	$\bar{3}$·6	$\bar{3}$·5
194	2·88	$\bar{3}$·6	$\bar{3}$·5
72	1·89	$\bar{5}$·7	$\bar{6}$·7
87	2·00	$\bar{5}$·8	$\bar{5}$·3
87	2·02	$\bar{5}$·9	$\bar{5}$·3
118	2·19	$\bar{5}$·9	$\bar{4}$·2
131	2·24	$\bar{4}$·0	$\bar{4}$·5
41	1·49	$\bar{5}$·0	$\bar{7}$·7

Series 1 (continued).

t° C.	log p.	log x_s obs.	log x_s calc.
59	1·76	$\bar{5}$·5	$\bar{6}$·4
81	2·00	$\bar{4}$·7	$\bar{5}$·2
132	2·41	$\bar{3}$·3	$\bar{4}$·3
164	2·59	$\bar{3}$·4	$\bar{3}$·0

Transition temperature:
240° C. (calc.)

Series 2. Scolecite. c 23·906 mols. (obs.) decreasing to 23·836, but better agreement is obtained by taking c 23·975 mols., decreasing to 23·904. With this assumption $x_s = 0{\cdot}0016$, increasing to 0·0060.

t° C.	log p* obs.	log p* calc. 1.	log p* calc. 2.	δc.
90	0·08	$\bar{1}$·51	0·08	0·000
102	0·53	$\bar{1}$·91	0·48	0·000
113	0·98	0·28	0·85	0·001
140	1·71	1·11	1·72	0·006
110	0·59	0·20	0·77	0·000
125	1·32	0·67	1·22	0·002
138	1·63	1·07	1·59	0·005
146	1·79	1·25	1·75	0·007
157	2·08	1·57	2·03	0·012
171	2·32	1·88	2·28	0·021
184	2·50	2·13	2·48	0·032
198	2·66	2·45	2·75	0·045

* Log p (calc. 1) is derived by taking the observed value of c, log p (calc. 2) by using the above assumed value.

TABLE IX (*continued*).

Series 2 (*continued*).

C.	log p* obs.	calc. 1.	calc. 2.	δc.
03	2·73	2·52	2·80	0·051
14	2·88	2·70	2·94	0·071
09	2·81	2·63	2·88	0·062
03	2·72	2·47	2·76	0·050
94	2·59	2·41	2·73	0·038

ransition temperature:

40° C. (calc.)

Series 3. Scolecite. *c* 23·77 mols. bs.), decreasing to 23·72, but better greement is obtained by taking *c* 3·86, decreasing to 23·81. With this ssumption $x_s = 0·009$, increasing to 012.

C.	log p* obs.	calc. 1.	calc. 2.	δc.
20	0·23	0·17	0·42	0·000
84	0·42	0·31	0·57	0·000
87	0·97	0·65	0·91	0·001
38	1·28	0·99	1·26	0·002
55	1·52	1·14	1·39	0·003
70	1·89	1·52	1·77	0·008
38	2·05	1·70	1·95	0·012
32	2·15	1·80	2·04	0·014
56	2·41	2·09	2·31	0·029
06	2·58	2·32	2·54	0·036
12	2·68	2·44	2·66	0·045
17	2·76	2·53	2·75	0·054

ransition temperature:

0·0° C. (calc.)

Series 4. Scolecite and metascolecite. *c* 23·36 mols., decreasing to 23·29, 0·040, increasing to 0·045, x_m 0·090, $< 3 \times 10^{-5}$.

°C.	log p obs.	calc.	δc.
olecite:			
26	$\bar{1}$·85	$\bar{1}$·88	0·00
44	0·46	0·46	0·00

Series 4 (*continued*).

t° C.	log p obs.	calc.	δc.
160	0·99	0·85	0·00
174	1·32	1·19	0·00
190	1·67	1·63	0·00
207	2·00	1·93	0·01
218	2·26	2·18	0·02
228	2·43	2·38	0·03
238	2·60	2·57	0·04
Transition conditions (calc. for x_s 0·040):			
243	—	2·68	—
Metascolecite:			
244	2·72	2·71	0·05
249	2·82	2·79	0·06
253	2·88	2·82	0·07

Series 5. Scolecite and metascolecite. *c* 21·73 mols., x_s 0·142, x_m 0·284, $x_m' < 0·0002$.

t° C.	log p obs.	calc.
Scolecite:		
158	$\bar{1}$·90	0·30
163	$\bar{1}$·90	0·39
175	0·62	0·76
191	1·11	1·13
183	0·83	0·88
207	1·50	1·48
217	1·66	1·67
227	1·89	1·82
Transition conditions (calc.):		
230	—	1·98
Metascolecite:		
237	2·13	2·09
242	2·20	2·18
252	2·34	2·33
260	2·48	2·41
267	2·65	2·53
277	2·74	2·64

* Log p (calc. 1) is derived by taking the observed value of c, log p (calc. 2) using the above assumed value.

TABLE IX (*continued*).

Series 6. Scolecite and metascolecite. c 20·06 mols., x_s 0·246, x_m 0·492, $x'_m < 0·0005$.

	log p	
$t°$ C.	obs.	calc.
Scolecite:		
192	0·99	0·95
200	1·18	1·15
218	1·46	1·50
232	1·78	1·79
Transition conditions (calc.):		
253	—	2·16
Metascolecite:		
261	2·15	2·24
268	2·30	2·36
276	2·42	2·48
280	2·48	2·52
290	2·67	2·65

Series 7. Scolecite and metascolecite. c 17·50 mols., x_s 0·406, x_m 0·812, $x'_m < 0·0005$.

	log p	
$t°$ C.	obs.	calc.
Scolecite:		
196	1·23	0·93
182	0·95	0·58
208	1·23	1·17
220	1·43	1·41
228	1·56	1·55
Transition conditions (calc. and obs.):		
243	1·70	1·74
Metascolecite:		
248	1·91	1·90
261	2·10	2·09
273	2·22	2·27
280	2·31	2·34
294	2·50	2·50
302	2·65	2·62

Series 8. Scolecite and metascolecite. c 16·46 mols., x_s 0·467, x_m 0·93 to 0·932, x'_m 0·001 to 0·003; x'_m increase with rise of temperature.

	log p	
$t°$ C.	obs.	calc.
Scolecite:		
183	0·53	0·51
190	0·85	0·75
Transition conditions (calc.):		
197	—	0·86
Metascolecite:		
198	0·95	0·93
212	1·23	1·12
222	1·40	1·27
242	1·57	1·49
253	1·78	1·72
270	2·06	1·95
276	2·13	2·02
286	2·27	2·13
292	2·31	2·21
302	2·43	2·26
316	2·54	2·38
322	2·60	2·48
328	2·70	2·53
330	2·73	2·66

Series 9. Metascolecite. c 16·0 mols., $x_m + 2x'_m$ 0·990, increasing t 0·993.

	log p			
$t°$ C.	obs.	calc.	x_m.	x'_m.
Transition conditions (calc.):				
84	—	$\bar{2}$·75	0·990	$3 \times 10^-$
Metascolecite:				
186	0·0	0·04	0·990	0·0002
202	0·5	0·40	0·989	0·0003
222	0·70	0·77	0·989	0·0005
243	0·85	1·14	0·988	0·0010
264	1·34	1·44	0·987	0·0013
299	1·99	1·92	0·985	0·0025

TABLE IX (*continued*).

Series 9 (*continued*).

	log p			
C.	obs.	calc.	x_m.	x'_m.
270	1·43	1·56	0·987	0·0016
298	1·99	1·92	0·985	0·0025
311	1·86	2·10	0·984	0·0030
245	1·08	1·10	0·988	0·0009
272	1·48	1·56	0·987	0·0016
297	1·74	1·92	0·985	0·0025
310	1·88	2·10	0·984	0·0030
332	2·10	2·30	0·983	0·0041
354	2·32	2·58	0·981	0·0055
373	2·42	2·82	0·978	0·007
381	2·49	2·94	0·976	0·008
391	2·58	3·04	0·974	0·009
395	2·63	3·09	0·973	0·010
415	2·72	3·29	0·971	0·011

Series 10. Metascolecite. *c* 15·54 mols., $x_m+2x'_m$ 1·0575, increasing to 1·0588.

	log p			
°C.	obs.	calc.	x_m.	x'_m.
397	1·98	2·60	0·9948	0·0317
409	2·16	2·79	0·9940	0·0324
391	1·95	2·54	0·9950	0·0319
380	1·78	2·34	0·9952	0·0314
373	1·72	2·29	0·9956	0·0312
363	1·60	2·09	0·9960	0·0310
350	1·49	1·84	0·9968	0·0305
340	1·32	1·64	0·9975	0·0301
334	1·20	1·50	0·9978	0·0300
281	0·47	0·59	0·9997	0·0289
292	0·60	0·78	0·9991	0·0292
301	0·72	0·99	0·9987	0·0295
333	1·20	1·50	0·9978	0·0300
369	1·63	2·23	0·9971	0·0304

*Series 11.** Metascolecite. *c* 15·20 mols., x_m 0·999, decreasing to 0·996, x'_m 0·051, increasing to 0·057.

	log p	
t° C.	obs.	calc.
336	0·3	1·31
339	0·7	1·38
358	0·97	1·78
363	1·11	1·86
369	1·20	1·99
375	1·36	2·06
390	1·59	2·31
405	1·80	2·53
415	2·02	2·72

Series 12.† Metascolecite. *c* 13·52 mols., x_m >0·999, x'_m 0·155.

	log p	
t° C.	obs.	calc.
315	$\bar{1}$·7	0·51
336	0·4	0·85
375	1·32	1·60
380	1·43	1·70
391	1·59	1·88
404	1·92	2·07
409	2·01	2·15
417	2·11	2·28

Series 13. Metascolecite. *c* 11·84 mols., x_m >0·999, x'_m 0·26.

	log p	
t° C.	obs.	calc.
297	$\bar{1}$·7	$\bar{1}$·89
316	0·0	0·29
340	0·57	0·77
356	0·84	1·03
362	1·00	1·17
367	1·15	1·28

* It is clear that final equilibrium was not attained in this series. The time between dehydration and the commencement of pressure readings was probably insufficient for complete lattice shrinkage. An error in weighing the water pumped off would also account for the discrepancy, but the error would have to be large—10·5 mg.

† Final equilibrium was probably not attained in the earlier measurements of this series.

TABLE IX (*continued*).

Series 13 (*continued*).

$t°$ C.	log p obs.	log p calc.
371	1·32	1·38
380	1·42	1·48
391	1·73	1·63
397	1·85	1·72
402	2·04	1·82
409	2·22	1·93

Series 14. Metascolecite. c 11·35 mols., $x_m > 0{\cdot}999$, x'_m 0·29.

$t°$ C.	log p obs.	log p calc.
268	$\bar{1}$·8	$\bar{1}$·29
290	0·15	$\bar{1}$·75
315	0·53	0·23
365	1·46	1·26
373	1·55	1·38
391	1·83	1·63
407	2·18	1·93
380	1·85	1·48
364	1·56	1·17
358	1·48	1·03

*Series 15.** Metascolecite. c 5·40 mols., $x_m > 0{\cdot}999$, x'_m 0·663.

$t°$ C.	log p obs.	log p calc.
336	1·23	0·58
362	1·54	1·12
375	1·78	1·33
387	2·00	1·55
395	2·26	1·67
402	2·32	1·80
411	2·41	1·94

Series 16. Metascolecite. c 5·17 mols., $x_m > 0{\cdot}999$, x'_m 0·677.

$t°$ C.	log p obs.	log p calc.
336	0·83	0·47
365	1·15	1·20
388	1·45	1·44
403	1·81	1·69
412	2·19	1·83

* The cause of the anomalously high pressures observed in this series remains uncertain.

This conclusion that the water in scolecite consists of a more volatile group of sixteen and a less volatile group of eight molecules tends to support W. H. Taylor's suggestion as to the probable crystal-structure of scolecite (1933) as against L. Pauling's (1930). In both structures sixteen water molecules occupy the same positions as in natrolite, which agrees with the fact that the heats of hydration of natrolite and of the sixteen-molecule group in scolecite are very similar. But in Pauling's structure the other eight water molecules occupy the positions of eight of the sodium atoms of natrolite, and are each surrounded by four oxygen atoms and two water molecules, all at 2·5 Å. distance, the nearest calcium atom being 3·6 Å. away; in such a position the eight water molecules should be much more loosely attached than the sixteen, which are only 2·5 Å. from the calcium atoms. In Taylor's structure, on the other hand, the eight water molecules are if anything rather nearer the calcium atoms (2·3 Å.) than are the sixteen, which would agree with their rather

ver volatility. Moreover, it will be shown below that in meta-lecite the relative volatilities of the two groups are reversed, and seems more probable that such a reversal could be effected by all adjustments of the atomic positions in Taylor's structure than Pauling's.

The lattice-shrinkage factor, $\phi(x_s)$, in the vapour-pressure equation, a very high value for scolecite, indicating considerable lattice inkage. In agreement with this is the fact that scolecite, de-drated to a loss of 1·43 % H_2O (2·5 mols.), had a specific gravity of 2·260, whereas the value calculated from the specific gravity fully hydrated scolecite, assuming no lattice shrinkage, is 2·243, hrinkage of nearly 0·8 %.

Metascolecite.

t has been shown above that the consideration of the vapour-ssure data leads to the conclusion that there exists a high-perature dimorphous form of scolecite, and optical evidence ws that this must be identical with the metascolecite of F. Rinne 90). The higher-temperature results of series 4 to 8 and the ble of series 9 to 16 represent the vapour-pressure relations of species. On examination, it appears that there is a more volatile up of eight water molecules and a less volatile group of sixteen. vapour pressures are well represented by the equations:

$$\log p$$
$$M_o + \tfrac{1}{2}\log T - \log x_m/(1-x_m) - 2\log\{1+\psi(x_m)\} - E/RT.\log_e 10$$
$$M'_o + \tfrac{1}{2}\log T - \log x'_m/(1-x'_m) - 2\log\{1+\Phi(x'_m)\} - E'/RT.\log_e 10$$

ere x_m, E, and M_o refer to the more volatile group of eight water ecules, and x'_m, E', and M'_o to the less volatile group of sixteen). values of the constants are: E $1{\cdot}75\times10^4$ cals. per gram-mol.), M_o 7·62, $\psi(x_m) = -0{\cdot}8\ x_m$, E' $3{\cdot}03\times10^4$ cals., M'_o 9·52, and $x'_m) = -0{\cdot}9\ x'_m$.

he transition equation for the scolecite $\rightleftharpoons$ metascolecite equili-m may therefore be written:

$$1000/T = 1{\cdot}65 - \log(1-x_m)(1-0{\cdot}45\ x_m)^2/(2-x_m)(1-0{\cdot}8\ x_m)^2.$$

his gives a transition curve which varies only between 230° and ° C. over the hydration range 24 to 17 mols. H_2O per unit cell, then drops sharply, reaching room-temperature for a composition near 16·00 mols. (see figs. 3 and 4); this circumstance explains fact that the maximum water content of metascolecite has

generally been supposed to be 16 mols. per unit cell. This suppos tion is quite untrue, for from the above transition equation, scolecit should transform into metascolecite if the temperature exceeds 255° C whatever its water content; and when scolecite is heated in contac with liquid water, the transformation should take place at 240° C under 25,000 mm. Hg (33 atmos.), to give a metascolecite containin 23·990 mols. H_2O per unit cell.

Owing to the difficulty in establishing the vapour-pressure con stants with any accuracy, especially the functions $\phi(x_s)$ and $\psi(x_m)$ the above transition curve cannot be regarded as of any grea accuracy, but it is believed to be substantially correct.

The above equations reproduce series 7 and 8, the high-tempera ture part of series 5 and 6, and series 12, 13, 14, and 16 very well Series 11 and 15 are not satisfactory, the former probably owing t insufficient time being given for equilibrium to be established Series 9 and 10 show fair agreement considering that a small erro in the observed degree of hydration would have a very marked effec on the calculated vapour pressure in these series. Series 9, with composition very near 16 mols. water per unit cell, shows clearly the tendency for the water to become more equally distributed ove the different sets of lattice positions as the temperature rises.

The optical properties found for the high-temperature form agre almost completely [1] with those found for metascolecite by F. Rinn (1890, 1894) and A. Cavinato (1927, 1928), but no evidence could b found to confirm the latter's view that there are three phases in volved, with different maximum water contents (3, 2, and 0 H_2O t $CaAl_2Si_3O_{10}$). All the evidence seems rather to indicate that th maximum water content for both scolecite and metascolecite is 2 mols. per unit cell, and that there is no third polymorph. Th difference between the X-ray powder photographs of metascolecite- ($CaAl_2Si_3O_{10}.2H_2O$) and metascolecite-II (anhydrous) found b Cavinato (1927) is probably due to lattice shrinkage, which would also account for the loss of reversibility when the dehydration i carried nearly to completion.

A pair of Lauegrams taken by Mr. Bannister agree with those o F. Rinne (1923) and A. Cavinato (1927) in showing the monoclini

[1] The author finds for a metascolecite with about 5 mols. H_2O per unit cell $\beta : c = 5° \pm$, birefringence very weak, n 1·523; and for a metascolecite with 16 mols H_2O per unit cell, $\beta : c = 18° \pm$, birefringence 0·01 $\pm$, n 1·505. These refractive indices are markedly lower than Cavinato's values.

nmetry of metascolecite and confirming the position of the nmetry plane relative to its position in scolecite, found optically F. Rinne (1890). Rotation photographs indicate considerable ice shrinkage, but cannot be indexed. Density determinations w clearly a marked shrinkage in metascolecite with 16·03 mols.) per unit cell, as compared with scolecite with 21·5 mols., and it

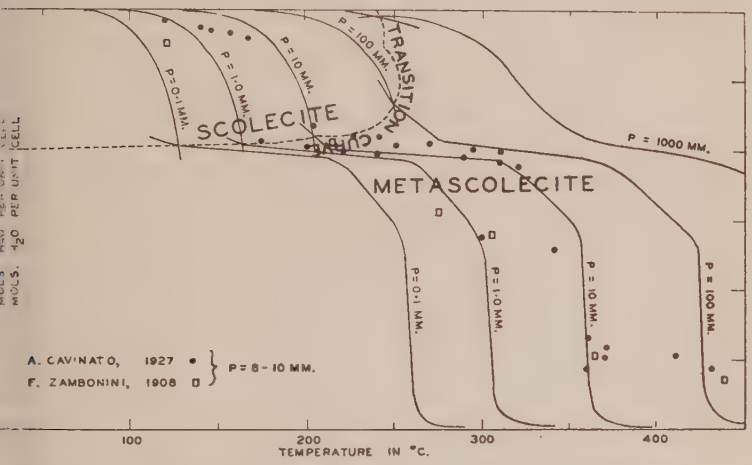

Fig. 4. Isobaric dehydration curves of scolecite and metascolecite.

ms probable that much of this shrinkage takes place during the nsition. For metascolecite with 16·03 H_2O, $D_4^{19} = 2{\cdot}441$; calcu- ed without allowing for lattice shrinkage, 2·172, or allowing for inkage at the rate found for scolecite, 2·225.

Metascolecite is strongly pyroelectric (Sir David Brewster, 1821, 22; F. Rinne, 1894), and X-ray photographs, though poor, confirm evidence of the distribution of the pyroelectric charge that the nmetry is still planosymmetric; it was not possible to establish space-group. Owing to the low conductivity of dehydrated tascolecite and its great power of keeping its own surface truly by absorbing any moisture film, the pyroelectric charge is very sistent, dehydrated metascolecite powder balling into lumps as if ist weeks after the charge was first developed if it is kept in a led tube.

H. Michel (1920) described material from Hegeberg, Eulau, Boden- ch, Bohemia, which he had formerly (1911) described as okenite, l regarded it as natural metascolecite. The chemical composition

was that of a fully hydrated scolecite, but it differed optically. The optics were not, however, those of metascolecite, and the identification must be incorrect; it is not possible to identify the material from the data given, and further investigation is very desirable.

It is possible that some of the base-exchange products above described may be really metascolecites; it would be interesting to test the matter, but very difficult.

Summary.

Two new chemical analyses, combined with optical data, confirm the conclusion of J. Wyart (1933) that the unit-cell formula of scolecite is $Ca_8Al_{16}Si_{24}O_{80}.24H_2O$. The limit of natural substitution of Ca by Na_2 appears to be about 1 atom Na per unit cell, and by K_2 about 0·1 atom. The crystal elements as deduced from X-ray and goniometric measurements agree excellently. The cell size is a 18·48, b 18·95, c 6·54 Å., β 89° 21′, and the space-group S^4. A detailed optical study of one of the analysed specimens was made. Base-exchange experiments were made, introducing $Na^{\cdot}$, $K^{\cdot}$, $Li^{\cdot}$, $NH_4^{\cdot}$, $Ag^{\cdot}$, and $Tl^{\cdot}$ in place of $Ca^{\cdot\cdot}$, and the effect on the optical properties studied; in several cases the products were natrolites, confirming the view that natrolite and scolecite are isostructural. Vapour-pressure study showed that on partial dehydration a transition to metascolecite occurs at a degree of hydration dependent on the temperature of the experiment; except at low temperatures, the transition occurs considerably before the composition $CaAl_2Si_3O_{10}.2H_2O$, commonly attributed to metascolecite, is reached. In both scolecite and metascolecite the water consists of two distinct groups, in scolecite a more volatile one of sixteen and a less volatile one of eight mols. per unit cell; in metascolecite the group of eight is the more volatile. The vapour-pressure constants of both groups have been ascertained for metascolecite, and of the first for scolecite. There is no evidence that anhydrous metascolecite constitutes a third crystal phase. The vapour-pressure data tend to support the crystal-structure suggested for scolecite by W. H. Taylor, C. A. Meek, and W. W. Jackson, rather than that proposed by L. Pauling. The material described by H. Michel as natural metascolecite was incorrectly identified.

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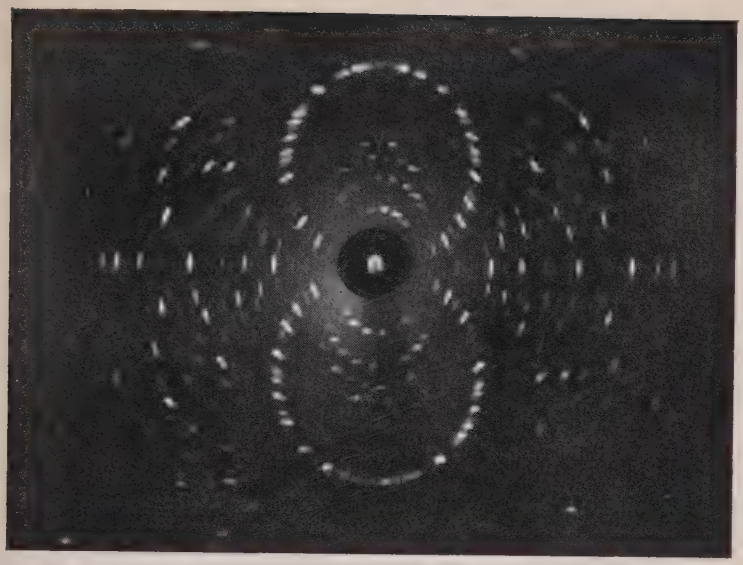

Fig. 1

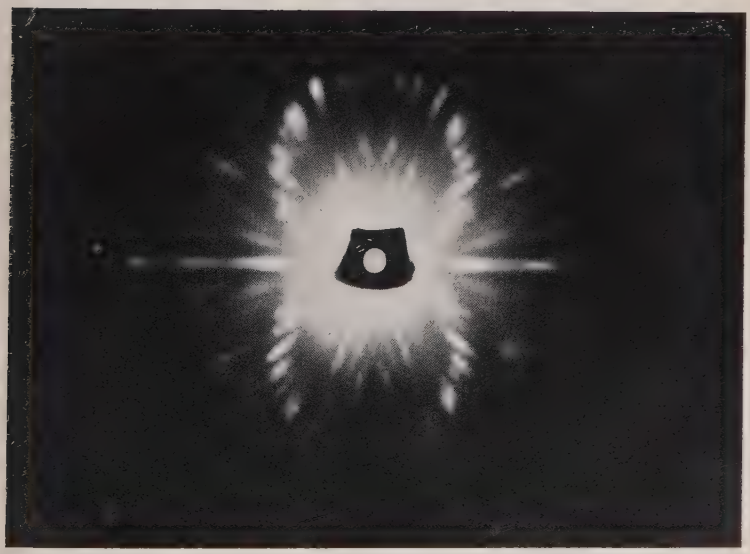

Fig 2

M. H. Hey: Scolecite and Metascolecite

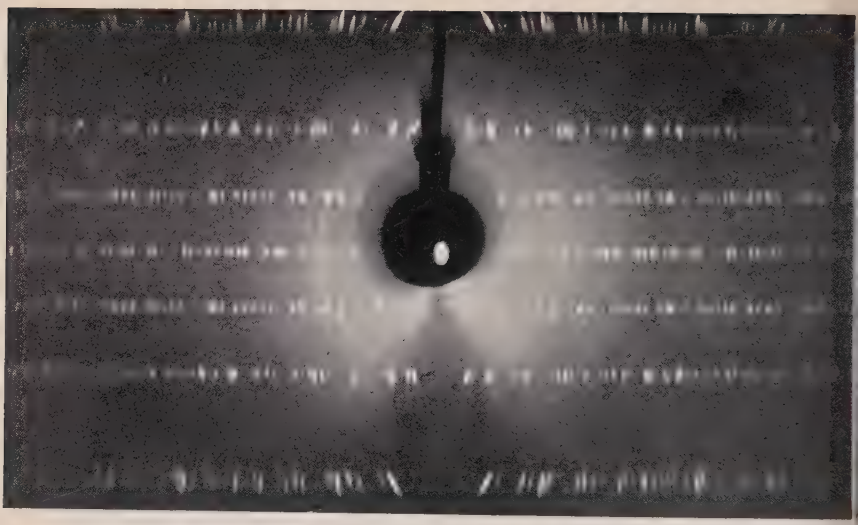

Fig. 3

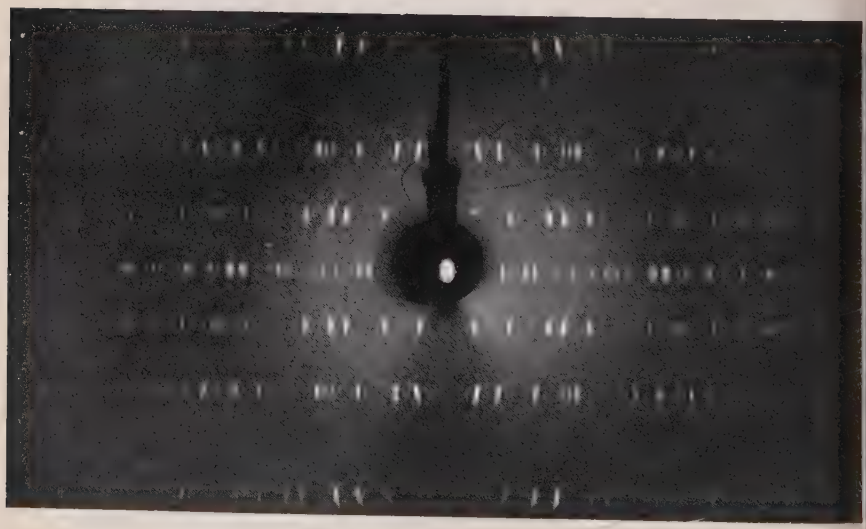

Fig. 4

M. H. Hey: Scolecite and Natrolite

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Explanation of Plates VIII and IX.

X-ray photographs of scolecite and metascolecite (and natrolite).

Plate VIII. Fig. 1. Laue photograph of scolecite (single crystal) along the axis *b*[010].

,, Fig. 2. Laue photograph of metascolecite twin along the axis *a*[100], which corresponds to *b*[010] of scolecite. The same crystal was used as for fig. 1, and the photograph taken in the same direction. (Intensifying screen used.)

Plate IX. Fig. 3. Rotation photograph of scolecite about the axis *c*[001]. (Cu-K_α radiation, λ 1·539 Å.)

,, Fig. 4. Rotation photograph of natrolite about the axis *c*[001] for comparison with fig. 3. (Cu-K_α radiation, λ 1·539 Å.)

Variability of garnet in granites.

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[Read January 26, 1933.]

IN extending earlier work on the distribution and significance of manganiferous garnet in the Dartmoor granites,[1] the senior author found it necessary to determine whether the average composition of the Dartmoor species was fairly represented by the single complete analysis (II, below) hitherto available—that of an aggregate of garnet fragments separated from crushed tor-granite.

As a preliminary step a similar aggregate from the cordierite-rich granite exposed in the Sweltor quarry was analysed (I). Comparison of the two analyses reveals an important variation in respect of MnO content:

	I.	II.
SiO_2	36·45 %	37·23 %
TiO_2	0·69	nil
Al_2O_3	21·01	20·66
Fe_2O_3	2·10	1·33
FeO	32·89	29·67
MnO	3·45	7·30
MgO	0·95	2·00
CaO	2·43	1·31
H_2O above 110° ...	n.d.	0·57
H_2O below 110° ...	n.d.	0·13
	99·97	100·20
Sp. gr.	4·003	4·000

Atomic percentages: I. $Fe_{80}\ Mn_{8·5}\ Mg_4\ Ca_{7·5}$. II. $Fe_{70}\ Mn_{17}\ Mg_9\ Ca_4$.

I. Garnet from the cordierite-rich contaminated granite, Sweltor quarry, west Dartmoor. Loc. cit., fig. 6, p. 187. Analyst, T. Marrack.

II. Garnet from Chinkwell Tor, east Dartmoor. Loc. cit., anal. no. 68, and Pl. XIII, fig. 6. Analyst, Dr. H. F. Harwood.

[1] A. Brammall and H. F. Harwood, The Dartmoor granites: their genetic relationships. Quart. Journ. Geol. Soc. London, 1932, vol. 88, pp. 189–191.

The probability that these two analyses did not cover the whole nge of the MnO variation made supplementary determinations sirable. The fact of variation among the fragments composing an gregate is readily determinable by exploiting small specific gravity ferences, using a diffusion column of Clerici solution calibrated by ans of index minerals of known specific gravity. Where any gregate mentioned in the following list distributed itself over a nificant density range, this range is indicated, together with responding MnO percentages determined by Dr. A. W. Groves:

Supplementary data for garnet aggregates.

	Sp. gr.	MnO %.
m tor-granites and their detritus:		
Top Tor, east Dartmoor	4·2	22·00
Saddle Tor, east Dartmoor	4·1–4·2	10·30
Tor detritus: R. Dart, below Dartmeet	3·7–4·2	9·47
,, ,, Dartmeet	4·1	8·99
,, ,, West Webburn stream	4·1–4·2	8·15
,, ,, East Webburn stream	4·1–4·2	8·08
,, ,, Dartmeet	4·1	7·33
Cf. Analysis II	4·0	7·30
m granites below tor-horizons:		
Below Vixen Tor, west Dartmoor	n.d.	4·64
,, Hamel Down, east Dartmoor	3·7–4·2	4·00
,, North Hessary Tor (Princetown quarry) ...	3·7–4·2	3·80
m cordierite-rich granites:		
Wall-like mass, ¼-mile south-west of Rippon Tor	3·7–4·2	3·70
Pithill, near Ivybridge	3·7–4·1	3·37
Cf. Analysis I	4·003	3·45
m a hornfelsed shale-xenolith:		
Cordierite-spinel-andalusite-hornfels	ca. 4·0	5·0±0·5

These results, which show a wide variation range (MnO 3·37–0 %), establish the fact of pronounced variation in garnet from e and the same granite-type. That such variation may be appreble even in garnet from one and the same hand-specimen is shown the following determinations:

	Sp. gr.	MnO %.
Burrator quarry: single crystal, fragmented and freed from traces of chlorite, &c.	3·7–4·1	4·95
Burrator quarry: single crystal, as above ...	3·7–4·1	3·56

Variability in garnet occurring as an accessory mineral in granite not restricted to the Dartmoor species. A further example is vided by garnet from the Eskdale granite in Cumberland. Garnet

aggregates separated from each of two granite facies, both visibl garnetiferous and represented in a single block, gave the followin results:

Eskdale granite: garnet from	Sp. gr.	MnO %
(*a*) a 2-inch vein of fine-grained aplogranite ...	>4·15 ...	7·08
	<4·15 ...	4·15
(*b*) the normal biotite-granite	>4·2 ...	7·36
	<4·2 ...	6·59

In conclusion, it may be stated that both the basic mica and th cordierite associated with the garnet in the Dartmoor granites ar similarly polyvarietal, even in the same hand-specimen of granite.

The authors acknowledge their obligation to Professor P. G. H Boswell, F.R.S., for laboratory facilities placed at their disposal.

The variable composition of cordierite in the Dartmoor granites.

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[Read January 25, 1934.]

THE recognition of pronounced varietalism in both the garnet[1] and the basic mica[2] of the Dartmoor granites prompted the authors to inquire whether the cordierite associated with these species was similarly variable in composition.

The inquiry was directed in the first instance to possible variation in the optic axial angle 2V, which is determinable with accuracy on the unaltered parts of cordierite in thin rock sections. Determinations made on the sector-twinned cordierites in the garnetiferous granite of Sweltor[3] gave the following peculiar results, which Mr. Rama Rao verified repeatedly, using a Fedorov microscope in perfect adjustment.

Values of 2V determined on 114 twin units (sectors and lamellae) of cordierite in fourteen thin sections of the Sweltor granite:

(*a*) $2V = 56° - 59°$ in 14 cases.
$= 60° - 69°$,, 80 ,,
$= 70° - 72°$,, 20 ,,

A value $62{\cdot}5° \pm 0{\cdot}5°$, previously determined by Mr. W. Campbell Smith, falls in the middle of this range.[4]

(*b*) The range is sometimes spanned by values determined on a single crystal.

(*c*) With few exceptions, optically continuous sector-pairs give concordant 2V values which, however, differ from those for adjacent sectors by amounts up to $13° - 14°$.

(*d*) All the occurrences examined are optically negative.

Typical examples of the variation scheme are shown in fig. 1, *b–f*.

[1] A. Brammall and S. Bracewell, Min. Mag., 1936, vol. 24 (preceding paper).
[2] A. Brammall and H. F. Harwood, Quart. Journ. Geol. Soc. London, 1932, vol. 88, pp. 184, 217, and fig. 19, p. 215.
[3] Loc. cit., 1932, fig. 6, p. 187.
[4] Loc. cit., 1932, p. 186.

When first observed, this variation was regarded with suspicion both authors, who, while claiming that the values determined correct within $\pm 1°$, hesitated to accept its implications and examined the case on the assumption that the peculiar scheme variation might be due to zoning or overlap of twin-units. Neitl of these possibilities could be seriously entertained: zoning, thou actual, is uncommon and, at best, feeble—no significant variation 2V occurs within the limits of a single sector; overlap zones narrow and easily avoided, and no abnormal interference-figu were observed. Still, the foregoing data—considered as evidence contrasted composition in adjacent sectors—may prove to be eq vocal; but the fact of variable composition of fragmental cordier is placed beyond doubt by the following analytical data:

	FeO %.	MgO %.	Atomic ra Fe : Mg.
(*a*) Cordierite aggregate fractionated (six fractions) in the Clerici diffusion column:			
1. Mainly micaceous	6·20	9·3	0·37
2. Mainly pinite	6·36	8·9	0·40
3. Cloudy cordierite	5·85	7·6	0·43
4. Pale lavender-grey cordierite ...	8·18	3·58	1·28
5. Glass-clear lilac-blue cordierite ...	4·00	2·07	1·10
6. Similar to no. 5	7·75	4·36	0·99
(*b*) Cordierite aggregate previously analysed[1]	9·10	3·31	1·51

These results establish the fact of pronounced variation in Sweltor cordierite; they also show that the composition of cordier aggregate can vary from sample to sample of the granite.

Values for 2V determined on relict cordierite in the quarry-grani of Pithill (Ivybridge) and Haytor span a similar range. As this quiry forms part of an attempt to determine whether, and by wh criteria, the cordierite in these granites can be genetically linked w the pelitic sediments of the region, 2V values were determined the small untwinned cordierites in several sections of hornfel shale-xenoliths. The results for a typical section are plotted fig. 1 *a*, which shows the rock-slice in plan and also the sites of cordierites to which the 2V values severally refer. The distribut of these values is clearly related to banding which, in turn, is dou less related to the variable texture and composition of layers co posing the original sediment. The variation range of 2V in this c is 56° – 82°.

[1] Loc. cit., 1932. Analysis no. 69.

The authors acknowledge their obligation to Prof. P. G. H. Boswell, F.R.S., for laboratory facilities placed at their disposal; to Mr. J. G. C. Leech, A.R.S.M., D.I.C., whose technique in mineral separation overcame several serious difficulties; and to Miss Hilda Bennett, M.A., B.Sc., for the partial analyses of the cordierite extractions.

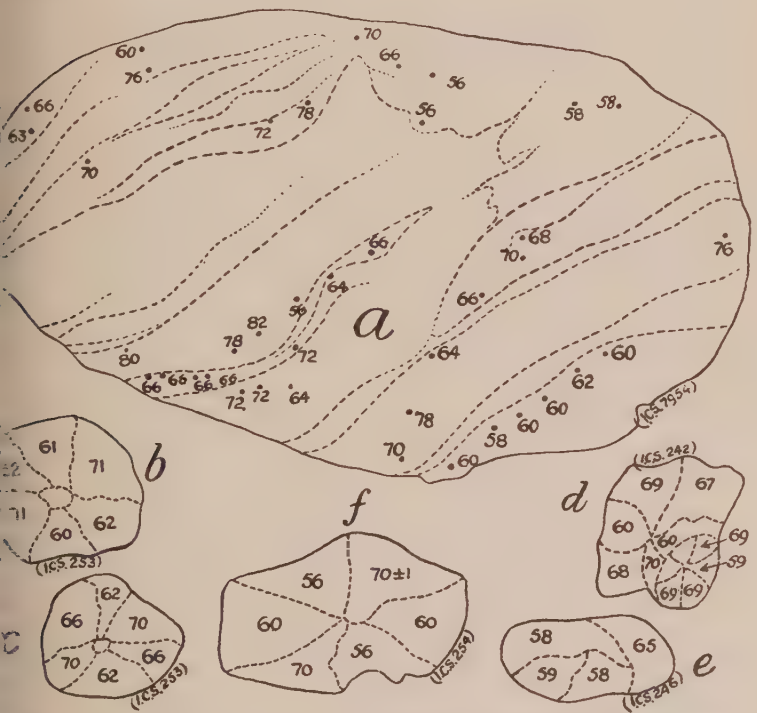

FIG. 1. (*a*) Plan of a thin slice of hornfelsed shale-xenolith from the tor-anite at Tunhill Rocks, east Dartmoor, showing (i) the sites of untwinned rdierite crystals, with the corresponding 2V values, and (ii) the variation of relative to banding in the original sediment. ×5.

(*b–f*) Plans of representative cordierite sections in thin slices of the garneti-ous granite of Sweltor, west Dartmoor, showing the variation of 2V relative sector-twinning. ×8–18. [I.C.S. number of section in the Geological De-rtment, Imperial College of Science.]

The distribution of gold and silver in the crystalline rocks of the Malvern Hills.

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[Read January 30, 1936.]

IN re-examining the crystalline rocks of the Malvern Hills, th senior author has had occasion to apply quantitative spectroscop data for the rarer constituents of hornblendes and micas. Th recognition of silver in the spectrograms of biotite led to tentativ fire-assays of granitic rocks in bulk—a procedure which revealed th presence also of gold.

The assay results for this preliminary suite of granitic types a given below; values less than 5 grains per ton are returned a 'traces':

Rock-type, and reference to 'List of localities', p. 263.	Number of samples assayed.	Gold grains per ton.	Silver dwt per ton.[1]
Granites: grey, pink, and reddish:			
Loc. *a*, *b*, *c*, *d*, *e*, and *j*	4 ...	trace ...	Av. 0·5
	5 ...	,, ...	,, 1·3
	2 ...	,, ...	,, 3·0
Granites: strongly reddened:			
Loc. *b*	2 ...	,, ...	,, 9·4
,, *d*	1 ...	,, ...	,, 33·6
,, *b*	1 ...	72 ...	,, 42·4
Pegmatites:			
Loc. *d*: grey; muscovite-rich ...	1 ...	trace ...	,, 0·4
,, *b*: red; quartz-felspar ...	3 ...	,, ...	,, 8·0

The higher values appear to be related to the reddening of th felspars, which is a widespread 'late' pneumatolytic effect; it conspicuous in the major granite masses and related pegmatites, b somewhat local and 'arterial' in its distribution over rocks of pr

[1] 1 pennyweight (24 grains) per ton (2240 lb.) = 1530 milligrams per metr ton (1000 kg.).

anite age. Among the igneous rocks of post-granite age, the intru-ve granophyric quartz-diabase ('Ivy Scar' type) shows only feeble ddening; the newer dolerites are unaffected.

As the contaminated character of the granite-granodiorite kindred re is one of the more obvious features, the possibility that their ntent of gold and silver might have been derived in the first instance om external sources rendered assay work on other rock-types bligatory.

The assemblage of Malvernian types sampled for this purpose mprises the following:

I. *Crystalline schists:*

(*a*) Sillimanite-bearing and garnetiferous quartz-, quartz-chlorite-, quartz-chlorite-mica-schists, with varieties containing felspars, hornblende, zoisite, epidote, apatite, sphene, ilmenite, magnetite, haematite flakes, and calcite in varying proportions.

(*b*) Biotite-rich schists of pelitic type, grading into varieties described above.

(*c*) Schisted sandstones. Stout ribs in granite are highly modified along their margins.

(*d*) Amphibolites, hornblende-schists, and hornblende paragneisses, grading into biotite-rich varieties, with varying amounts of quartz, felspar, garnet, epidote, &c.

(*e*) Phyllites, usually quartz-banded.

II. *The pyroxenite-hornblendite kindred* (with felspathic and micaceous riants) and related appinites, many of which are demonstrably of ixed' origin. In the main they are older than the red granite. th these may be grouped some intrusive masses of 'appinitic' rite, syenite, monzonite, &c., and a widespread 'gabbro-diorite' mparable to the rock quarried at Hollybush.

III. *Granites, granodiorites, &c.* The true granites belong to more n one time-stage in the Malvernian sequence. The older types represented by thin intercalates of grey granite, &c., and broader ds of granite, aplite, felsite, and granitoid paragneiss in the banded stalline schists. The newer granites are more massive, and typi-ly pink or red; they also contribute intercalates (locally tourma-ferous) to the injection-complex.

The red granite-pegmatites belong to the latest phase of granite-rusion.

The modification of granites, granodiorites, &c., to 'unakite' attributable to migratory solutions carrying the constituents epidote, with haematite, plagioclase, quartz, and sphene.

IV. *Post-granite intrusions* include the following:

A granophyric quartz-diabase type, most frequently encountere north of the Wyche. The type locality is Ivy Scar.

Dolerites.

At least one occurrence of appinite, which is intrusive into tl granophyric quartz-diabase.

V. *Epidosites*,[1] *epidote-quartz-, and epidote-quartz-plagioclase vei rock*. These are widely distributed, and traverse all types, includir those described in IV.

The supplementary assay-results are given in the followir sections:

Rock-type and locality.	Number of samples assayed.	Gold grains per ton.	Silver dwt per ton.
Crystalline schists:			Average.
Banded quartz-chlorite-sericite-phyllite. Loc. *k* ...	1 ...	trace ...	0·4
Quartz-chlorite-sillimanite-garnet-mica-schist. Loc. *f* ...	3 ...	,, ...	0·4
Quartz-chlorite-mica-schist. Loc. *a* ...	1 ...	,, ...	0·4
Banded schist-and-gneiss complex:			
Granitoid: grey, patchily reddened. Loc. *a* ...	2 ...	,, ...	0·4
,, *f* ...	5 ...	,, ...	0·5
,, *b* ...	2 ...	,, ...	1·1
,, *m* ...	2 ...	,, ...	2·4
,, ,, ...	2 ...	,, ...	2·5
,, *g* ...	1 ...	9 ...	5·2
,, ,, ...	1 ...	8 ...	21·5
Granitized schisted sandstones, in contact with red granite. Loc. *b* ...	2 ...	trace ...	2·0
,, ,, ...	1 ...	,, ...	6·8
,, *e* ...	1 ...	,, ...	10·4
Quartz and epidote:			
Quartz aggregate, from red granite and red granite-pegmatite. Loc. *a, b, c, d*	2 ...	trace ...	0·5
Epidosite. ,, *j*[2] ...	1 ...	nil ...	trace
,, ,, *g* ...	1 ...	,, ...	1·2

[1] A. F. Smethurst, Anomalies in the analytical determination of water epidote. Min. Mag., 1935, vol. 24, pp. 173–179.

[2] A. F. Smethurst, loc. cit., p. 176, analysis specimen A.

Rock-type and locality.	Number of samples assayed.	Gold grains per ton.	Silver dwt. per ton.
mphibolites and hornblende-schists:			Average.
Quartz-banded. Loc. *k* ...	6 ...	trace ...	1·2
Compact, uniform. ,, ,, ...	6 ...	,, ...	1·5
Migmatitic: highly modified by silica-rich solutions from red granite: reddish and purplish migmatites.			
Loc. *c* ...	1 ...	,, ...	4·6
,, ,, ...	1 ...	29 ...	0·7
Derivative epidiorites. ,, *b* ...	2 ...	trace ...	1·4
,, *h* ...	1 ...	,, ...	2·8
Derivative 'appinitic' diorites, 'Hollybush' type. Loc. *l* ...	2 ...	nil ...	trace
,, *b* ...	2 ...	,, ...	0·7
yroxenite-hornblendite kindred:			
Biotitite: pegmatitic. Loc. *c* ...	3 ...	,, ...	0·4
,, with grey felspars. Loc. *c* ...	2 ...	,, ...	trace
Hornblendite. ,, ,, ...	1 ...	,, ...	0·7
,, with grey felspars. Loc. *c* ...	1 ...	trace ...	1·2
Biotite-hornblende-pyroxenite. Loc. *c* ...	2 ...	nil ...	1·7
,, hybridized to coarse red appinitic pegmatite. Loc. *c* ...	1 ...	trace ...	8·3
Derivative granodiorite. ,, ,, ...	1 ...	,, ...	13·2
Biotite-hornblendite, with grey felspars. Loc. *c* ...	4 ...	,, ...	0·4
Appinitic derivatives. Loc. *c* ...	3 ...	nil ...	trace
uartz-diabase ('*Ivy Scar*' *type*): Loc. *i* ...	1 ...	trace ...	1·4
,, *e* ...	3 ...	,, ...	1·5
wer dolerites: ,, *b* ...	4 ...	,, ...	1·6
rite aggregate from schists: Loc. *c* ...	1 ...	5 ...	1·1
alcosine veinlet: ,, *j* ...	1 ...	trace ...	39·6
ult-gouges: ,, *c, d* ...	5 ...	tr.–4 ...	0·4

List of Localities.

a. Hay Slad quarries, ¼-mile nearly due south of Worcester Beacon.
b. ,, ,, ,, ¼-mile due south of Worcester Beacon.
c. Tollgate quarries, west side of main road, ⅛-mile north of Wyche.
d. ,, ,, ,, ,, ,, about ¼-mile north of Wyche.
e. Worcester Beacon.
f. Enclosure immediately north of the 'Gold Mine', ¼-mile north of Wyche.
j. Crag (east side of hill-track), ¼-mile SSW. of Worcester Beacon.
h. ,, ¼-mile ESE. of Worcester Beacon.

i. Ivy Scar crags.
j. North Malvern ('Pyx') quarries.
k. Gullet quarry.
l. Hollybush quarry.
m. Hill-side, about 400 yards due east of Worcester Beacon.

The results are consistent among themselves, and their correlati leads to the following conclusions:

1. In the more basic igneous rocks, comprising pyroxenites, ho blendites, appinitic diorites, &c., intrusive diorites and dolerites, t prevailing gold and silver values are low, of the order 1 grain of g and 1 dwt. of silver per ton.

2. The same low values prevail in
   (*a*) the grey granites and gneisses,
   (*b*) the granitoid crystalline schists and paragneisses,
   (*c*) amphibolites, hornblende-schists, and their biotitic varieti
   (*d*) hornblende, basic micas, muscovite, epidote, quartz, a basic plagioclase.

3. The higher values are associated with the red granites and r granite pegmatites, and with various types of 'mixed' rocks to wh the red granites have been contributory. They are probably relat to disseminations of haematite attributable to pneumatolytic p cesses which distinguish the latest phase of granite intrusion.

For the sampling schedule, and the interpretation of the ass results, the senior author alone is responsible. The actual sampli and the whole of the assay work were done by Mr. Dowie.

Both authors acknowledge their obligation to Prof. P. G. H. Boswe F.R.S., of the Geological Department, and to Prof. Sir Har Carpenter, F.R.S., of the Metallurgical Department, for laborat facilities placed at their disposal.

The Morven meteorite, an aerolite from South Canterbury, New Zealand.

By C. O. Hutton, M.Sc., F.G.S.
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[Read January 30, 1936; communicated by Prof. W. N. Benson.]

THE meteoric stone to be described was found in 1925 by Mr. William Stewart while ploughing on his farm four-and-a-half miles south of the Morven railway station (44° 49′ S., 171° 8′ E.) in South Canterbury, about one hundred miles north-east of Dunedin, New Zealand. It must have weighed originally about 7100 grams, but when presented to the Otago University Museum it weighed 14 lb. 14 oz. (6753 grams), the remainder having been broken off by the finder. There is no local record of the fall, and the nature of the weathered crust suggests that it may have been in the soil for a long time.

The stone (fig. 1) is roughly pyramidal, measuring approximately $22{\cdot}5 \times 17{\cdot}5 \times 15{\cdot}0$ cm. It was covered with a thin, soft ochreous crust occasionally as much as 2–3 mm. thick. Two of the faces are decidedly 'knobby', but the whole surface is pitted by deep 'thumb-marks'. Except for the absence of stream-marks and of flattish patches on the faces, the general appearance is that of the Mangwendi meteorite described by Lightfoot, Macgregor, and Golding.[1] Noteworthy is the presence of shearing surfaces which are exposed on breaking the meteorite. These are strongly slickensided and show generally a glossy black colour, except where a film of oxides occurs.

A polished surface displays many irregular steely bright grains of nickel-iron alloy, and small, occasionally encircling masses of bronze-coloured troilite, both set in a dark green to brownish-green silicate matrix, in which small chondrules may be seen. This matrix is stained to a varying degree by limonite films.

[1] B. Lightfoot, A. M. Macgregor, and E. Golding, The meteoric stone seen to fall in the Mangwendi native reserve, Southern Rhodesia, on March 7, 1934. Min. Mag., 1935, vol. 24, pp. 1–12.

Petrographical description.

A petrographic study shows that the meteorite may be termed crystalline chondrite.

Fig. 1. The Morven meteorite.

Chondrules.—The most abundant mineral, olivine, occurs as variou forms of chondrules. Some are perfectly rounded up to 0·75 mm. i diameter and are composed of tiny grains of olivine with a litt iron-ore. The largest aggregate of this structure is oval in cros section and 1·3 mm. long. Less often the constituent grains a coarse and set in a dusty greyish microcrystalline material, a trans tion to the porphyritic type of chondrule. Rarely the chondrul are composed of matted lath-like crystallites, 0·5 mm. long (fig. 2 D Some chondrules are monosomatic, that is, consisting of a sing grain, the largest being 0·4 mm. in diameter. The grains are cle and unbroken but occasionally show features approaching those

he barred type [1] of chondrule. Enstatite chondrules are rather less bundant, but more varied in character and reach 1·0 mm. in diameter. ome are little more than ovoid aggregates of minute grains (fig. 2 A),

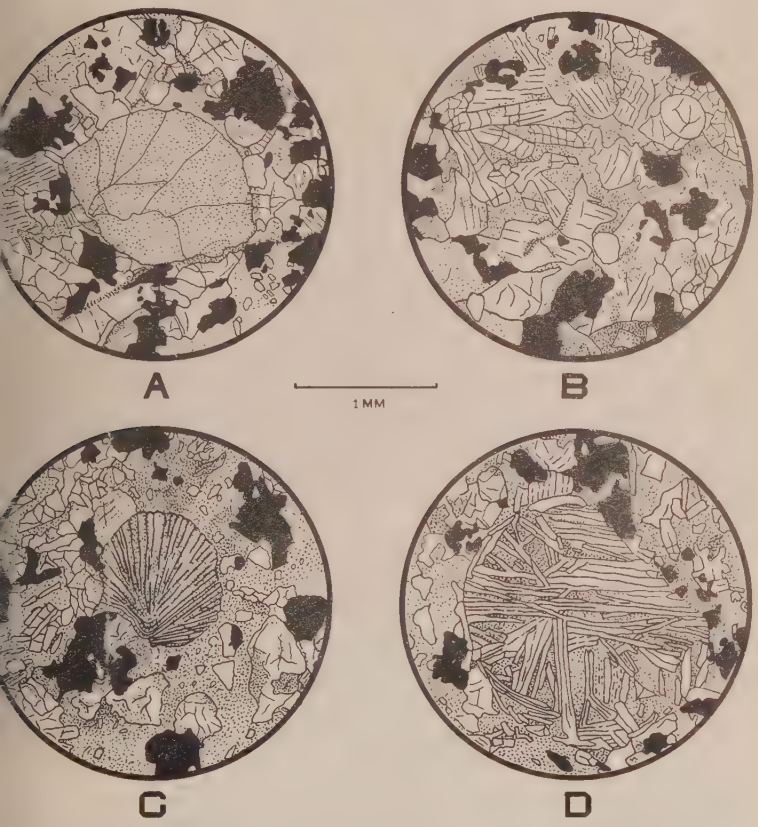

Fig. 2. Micro-sections of the Morven meteorite.

A. A chondrule of minutely fibrous enstatite surrounded by olivine, enstatite, oilite, and nickel-iron alloy.

B. An irregular chondrule composed of laths of enstatite embedded in a grey usty matrix and surrounded by a granular mass of olivine, with troilite and on-ore.

C. A radiating enstatite chondrule similarly surrounded.

D. A chondrule of prismatic crystals of olivine, with grey dusty matrix, rrounded by olivine, iron-ores, and a little enstatite.

[1] For example of this type of chondrule see R. E. S. Heineman, Petrography the Roy, Harding County, New Mexico, meteorite. Amer. Min., 1935, vol. 20, 439, fig. 3. [M.A. 6–104.]

perhaps deformed by shearing. In others, equally irregular, th grain size is less minute (fig. 2 B). Others again show a fibrous c prismatic radiating structure, which is often eccentric. More ofte there are seen merely sectors of a chondrule, seldom more tha hemispherical. In one of these the radiating fibres of one side a bent around the central point and are continued into the radial fibr of the opposite side (fig. 2 C). In one section a well-rounded grai of diopside, 1·0 mm. in diameter, occurs; it is well cleaved, wit extinction $c:\gamma$ of 37° and optically positive. The largest grain enstatite was of irregular form, 2·6 mm. in length, with wavy cleava lines and undulose extinction. It is granulated along fracture line This cannot, however, be considered part of a chondrule.

Metals and sulphides.—The nickel-iron alloy occurs as highly irreg lar masses, averaging 0·3 mm. in diameter (rarely up to 1·0 mm which may enclose grains of olivine and enstatite. Troilite (c pyrrhotine) is often intergrown with, or encloses, this alloy. Troili as rather abundant ragged grains, up to 0·4 mm. across, has a bron colour in reflected light and, in addition to being scattered through the rock, forms veinlets or thin sheets along the shearing planes.

The matrix.—The matrix is holocrystalline, consisting of an aggr gate of irregular grains of olivine and pyroxene with finely divid troilite and nickel-iron alloy. There are present also rare sma irregularly-shaped grains, not exceeding 0·3 mm. in diameter, co posed of a substance like maskelynite. They are isotropic a transparent, with a low refractive index, and they would appear have been among the latest minerals to crystallize. In addition these, there also occur a few chondrule-like aggregates compos entirely of dusty-grey minute granules with weak refringence a birefringence. Similar grey material frequently occurs as sma irregularly-shaped grains, interstitial to the grains of ferromagnesi silicates.

As a result of weathering, the minerals are frequently stained thin films of limonite.

Chemical analysis.

The general scheme of analysis was that used by the chemists the United States National Museum in the analysis of the Floren stone[1] and later by E. Golding for the Mangwendi stone (loc. ci p. 9). A chip of the meteorite was taken and ground up to p

[1] G. P. Merrill, The composition and structure of meteorites. Bull. U.S. N Mus., 1930, no. 149, p. 57. [M.A. 4–257.]

80-inch mesh. This powder was then spread out thinly on glazed paper and separated into magnetic and non-magnetic portions by means of a hand-magnet. The attracted portion was thoroughly reworked in order to rid it of as much non-magnetic material as possible, while the non-magnetic portion was likewise re-treated. The chip taken weighed 39·5 grams, and after magnetic separation the following results were obtained :—

Attracted portion	9·3585 grams
Unattracted portion	30·0224
	39·3809

Attracted portion.—The whole of the magnetic portion was then digested with aqua regia, then later with Na_2CO_3, as recommended by Merrill (loc. cit., p. 58), with the following results :—

Dissolved	7·7027 grams (19·55 % of whole)
Undissolved	1·6558
	9·3585

The washings and filtrate from the two digestions were combined and made up to one litre at 15° C., after the separation of silica. From this solution duplicate aliquot portions were taken for the various determinations and an average of the values obtained gives the following results :—

	Grams.		19·55 % of whole.
Soluble silicate :			
SiO_2	0·5274	...	1·339 %
TiO_2	trace	...	trace
Al_2O_3	0·0010	...	0·002
FeO	0·1923	...	0·488
MnO	0·0040	...	0·010
MgO	0·5756	...	1 462
CaO	0·0409	...	0·103
		1·3412	
Pyrrhotine (Fe_7S_8) :			
Fe	0·3702	...	0·939
S	0·2430	...	0·617
		0·6132	
Metal :			
Fe	5·0424	...	12·800
Ni	0·5418	...	1·376
Co	0·0422	...	0·107
Cu	nil	...	nil
P	0·0838	...	0·212
		5·7102	
		7·6646	19·455

Composition of metallic portion (14·50 % of whole meteorite):

Fe.	Ni.	Co.	P.	Pt metals.	Au.
88·31	9·49	0·74	1·47	trace	nil

In the estimation of Fe, FeO, Ni, Co, CaO, MgO, &c., analytica procedure was practically the same as that recommended by Merri (loc. cit., p. 59), with certain exceptions. The precipitation c aluminium and ferric hydroxides was done most carefully, sinc Lundell and Knowles[1] have shown it is difficult to effect a complet separation of these hydroxides from cobalt. Following their recom mendations a large amount of ammonium chloride and nitrate wer present in the solution and the *p*H value was carefully adjustec Four reprecipitations of these hydroxides were made. The nickel wa then estimated in the filtrate by precipitation with dimethylglyoxime the bulky red precipitate after filtering through a Gooch crucibl and washing, was treated with 5 c.c. of alcohol followed by ethe then dried for a short time *in vacuo*.[2] The estimations of Cc CaO, and MgO were then carried out as recommended by Merril (loc. cit., p. 59). As a check on the estimation of cobalt, 50 c.c of the original solution[3] were taken, precipitated four times wit ammonia, the precipitate each time being dissolved in 4*N* sulphuri acid. To the solution then freed from aluminium and iron, 10 gram of ammonium sulphate and a moderate excess of strong ammoni were added. This solution was electrolyzed using a rotating cathod and a current of 0·75 amps., until a spot-test showed that no trac of nickel remained in the liquid. The cathode was then weighed the increase in weight being due to the nickel and cobalt deposited. These two metals were then dissolved off the cathode with 1 : nitric acid, and the nickel in that solution determined gravimetrically as nickel dimethylglyoxime. The value obtained for nickel by thi method was almost identical with that obtained previously (0·541 and 0·5420 gram respectively), but the amount of electrolytic cobal (0·0422 gram) was slightly higher than that determined befor (0·0400 gram).

[1] G. E. F. Lundell and H. B. Knowles, The separation of iron and aluminiur from manganese and certain other elements. Journ. Amer. Chem. Soc., 192 vol. 45, pp. 676–681.

[2] C. A. Mitchell, Recent advances in analytical chemistry, London, 193 vol. 2, p. 272.

[3] This solution was evaporated to dryness several times with concentrated hy drochloric acid, in order to free from nitrates, before precipitation with ammoni

[4] Copper, if present, would have been precipitated under the same condition

Soluble silicate in the unattracted portion.—For the analysis of the soluble silicate portion, triplicate portions of two grams (2·0000) of the unattracted powder were taken and treated with aqua regia and later with Na_2CO_3 as was the case with the magnetic fraction. The average result was :—

Dissolved	1·0787 grams
Undissolved	0·9213
	2·0000

The average composition of the dissolved portion was :—

SiO_2	...	...	0·3339 grams	...	30·96 %
TiO_2	...	...	trace	...	trace
Al_2O_3	...	...	0·0340	...	3·15
FeO	...	...	0·2260	...	20·96
NiO	...	...	0·0151	...	1·40
CoO	...	...	nil	...	nil
MnO	...	...	0·0040	...	0·37
MgO	...	...	0·3285	...	30·47
CaO	...	...	0·0143	...	1·33
P_2O_5	...	...	0·0085	...	0·79
Fe	...	...	0·0684	...	6·35
S	...	...	0·0393	...	3·64
			1·0720		99·42

Insoluble silicate portions.—The insoluble residues that remain after the digestion of the attracted and unattracted portions were thoroughly mixed. Of this approximately one gram (0·9533 gram) was taken, fused with alkali carbonates, and analysed by standard methods, the chromite being decomposed by the addition of a little potassium nitrate to the fusion mixture. The analysis of the insoluble silicate gave the following results :—

SiO_2	...	...	0·5358 grams	...	56·21 %
TiO_2	...	...	0·0025	...	0·26
Al_2O_3	...	...	0·0570	...	5·98
Cr_2O_3	...	...	0·0018	...	0·19
FeO	...	...	0·0797	...	8·36
NiO	...	...	nil	...	nil
CoO	...	...	nil	...	nil
MnO	...	...	0·0030	...	0·31
MgO	...	...	0·2184	...	22·92
CaO	...	...	0·0325	...	3·41
Na_2O	...	...	0·0220	...	2·30
K_2O	...	...	0·0036	...	0·38
P_2O_5	...	...	nil	...	nil
			0·9563		100·30

From these various analyses the bulk chemical composition of the meteorite may be calculated as follows:—

	Attracted %.	Unattracted %.	Bulk Grams.	Bulk Per cent.
SiO_2	6·85	43·58	14·2404	36·160
TiO_2	trace	0·13	0·0402	0·102
Al_2O_3 ...	0·01	4·56	1·4371	3·649
Cr_2O_3 ...	nil	0·09	0·0294	0·075
FeO	2·50	14·66	4·8793	12·390
NiO	nil	0·70	0·2268	0·576
CoO	nil	nil	nil	nil
MnO	0·05	0·34	0·1020	0·259
MgO	7·47	26·69	9·0556	22·990
CaO	0·53	2·37	0·7833	1·989
Na_2O ...	nil	1·15	0·3559	0·904
K_2O	nil	0·19	0·0588	0·149
P_2O_5	nil	0·39	0·1276	0·324
P	1·09	nil	0·0838	0·213
Fe	70·28	3·17	6·4396	16·350
Ni	7·03	nil	0·5418	1·376
Co	0·55	nil	0·0422	0·107
Cu	nil	nil	nil	nil
S	3·16	1·82	0·8330	2·114
Pt	trace	—	trace	trace
Totals ...	99·52	99·84	39·2768	99·727
SrO	—	—	—	nil
$H_2O > 105°$ ...	—	—	—	nil
$H_2O < 105°$ ...	—	—	—	0·230
V_2O_3 ...	—	—	—	trace?
SO_3	—	—	—	trace
Cl	—	—	—	nil
			Grand total	99·957

Specific gravity of four chips (not chips analysed): 3·54, 3·55, 3·59, 3·62.

In order to determine the modal composition of the Morven meteorite, the author follows the writers on the South Rhodesian meteorite (loc. cit., p. 8) in treating the three analyses separately. It must be stressed, however, that certain compounds such as triplite and schreibersite, assumed for purpose of calculation, have not been identified in thin section, but the various molecules constituting these compounds may be divided between yet other modal compounds.

In the soluble magnetic portion, sulphur was reckoned as pyrrhotine, while the phosphorus was divided between the metallic phosphide, schreibersite, and the manganese and iron phosphate, triplite.

The lime was calculated as monticellite and included in the olivine, as lime has been reported in some analyses of olivines in meteorites.[1] The silica, magnesia, and some iron were combined to form olivine.

Modal Composition.

	Magnetic portion.	Insoluble silicates.	Soluble silicates.	Bulk.
Felspars:				
Orthoclase	—	0·76	—	0·76
Albite	—	7·66	—	7·66
Anorthite	—	1·92	—	1·92
Pyroxenes:				
Diopside	—	3·68	—	3·68
Bronzite	—	20·93	—	20·93
Olivine:				
Olivine	3·37	4·16	33·21	40·74
Spinellids:				
Chromite	—	0·11	—	0·11
Hercynite	—	—	2·21	2·21
Sulphides:				
Troilite	—	—	4·11	4·11
Pyrrhotine	1·56	—	—	1·56
Phosphorus compounds:				
Triplite	0·05	—	0·82	0·87
Schreibersite	1·30	—	—	1·30
Iron-ore:				
Ilmenite	—	0·20	—	0·20
Oxides:				
Nickel oxide	—	—	0·57	0·57
Metals:				
Iron	11·70	—	—	11·70
Nickel	1·38	—	—	1·38
Cobalt	0·11	—	—	0·11
Totals	19·47	39·42	40·92	99·81

The procedure in the case of the soluble silicate portion was similar, except that the sulphur was calculated as troilite and the alumina as hercynite. There remains, however, 1·4 % of nickel oxide which may represent nickel from the incompletely separated extracted portion or may quite possibly include also some nickel from the olivine. In view of this uncertainty it has been left as the uncombined oxide.

For the insoluble silicate portion, all the alkalis, alumina, and some lime were combined to form felspars, while the remainder of the lime was reckoned as diopside. The chromium and titanium

[1] C. Doelter, Handbuch der Mineralchemie, 1914, vol. 2, pt. 1, pp. 292, 301.

were calculated as chromite and ilmenite respectively, while th remainder of the bases were calculated as pyroxene together wit a little olivine, the manganese being included in the pyroxene.[1]

The modal composition is shown on the previous page.

For the purposes of comparison with other meteorites the follov ing data are given :—

(1) percentage of metal ('*f*') ... ... 13·1
(2) ratio of iron + cobalt to nickel in metal ('*n*') ... ... 9·5
(3) ratio of MgO to FeO in silicate by weight ... ... 2·4
,, ,, ,, by molecular proportion ('*m*') 4·3
(4) dominant felspar—basic oligoclase.

Classification.—The above data indicate that the Morven meteori belongs naturally to group 2 of class 3 of Prior's classification,[2] tha is, one of the Cronstad type. Following Prior (loc. cit., p. 61) ther the Morven meteorite is termed a veined brecciated grey bronzite olivine-chondrite. Petrographically it is rather similar to the Ro Mangwendi, and Makarewa stones, but differs chemically from the tw latter by reason of their lower iron content. Chemically the Morve meteorite bears a close resemblance to the following stones as show in the table below :[3]

	1.	2.	3.	4.	5.	6.	7.	8.	9.
f ...	13·19	18·5	11	17	15	10·5	17	14	15·5
n ...	9·58	11	8	11	8	9	10	10·5	10·5
m ...	4·36	5	4	4	4	3·5	5	4·75	5

1, Morven stone, South Canterbury, New Zealand. 2, Cronstad stone, Oran Free State, South Africa. 3, Homestead stone, Iowa, U.S.A. 4, Salt Lake Ci stone, Utah, U.S.A. 5, Lixna stone, Dvinsk, Latvia. 6, Marion stone, Lin County, Iowa, U.S.A. 7, Ogi stone, Hizen, Kyushu, Japan. 8, Cobija ston Pampa of Santa Barbara, Antofagasta, Chile. 9, Queens Mercy stone, Matatiel Griqualand East, Cape Province, South Africa.

The Morven stone is the fourth meteorite to be recorded fro New Zealand. Those previously known are :

Wairarapa Valley, Wellington, North Island. A stone of abou 30 lb. found in 1864 at Tohirua, near Masterton (40° 57′ S., 170° 40′ E. Jurors' Report, N.Z. Exhibition, 1865, Dunedin, 1866, p. 410

[1] For presence of manganese in orthorhombic pyroxenes see O. C. Farringto Meteorites. Chicago, 1915, p. 173.

[2] G. T. Prior, The classification of meteorites. Min. Mag., 1920, vol. 1 pp. 51-63.

[3] Data obtained from the British Museum Catalogue of Meteorites (1923) an appendix (1927) by G. T. Prior; the symbols employed are those used in th museum catalogue.

W. Flight, Geol. Mag. London, 1875, p. 556, and History of Meteorites, 1887, p. 140; G. R. Marriner, Trans. N.Z. Inst., 1910, vol. 42 (for 1909), p. 177.

Makarewa, Invercargill, Southland. A stone of 4 or 5 lb. found in 1879 when constructing the railway (46° 20′ S., 168° 20′ E.). G. H. F. Ulrich, Proc. Roy. Soc. London, 1893, vol. 53, p. 54; L. Fletcher, Min. Mag., 1894, vol. 10, p. 287; G. R. Marriner, loc. cit., p. 178. The place-name is incorrectly spelt Makariwa in the papers of Ulrich and Fletcher.

Mokoia, Taranaki, North Island (39° 38′ S., 174° 22′ E.). A shower of stones fell at 12.30 p.m. on November 26, 1908; two of about 5 lb. each were recovered. G. R. Marriner, loc. cit., p. 180.

In conclusion, it might be of interest to include here an abstract from Elsden Best's Dominion Museum Monograph (1922, no. 3, p. 57) on 'The astronomical knowledge of the Maori'.

Meteors are termed by the Maori *Tumatakohiri*, and other names derived therefrom. To some they were merely stars at their gambols, stars that have wandered out of their places and have been struck by their elders, the sun and the moon. The appearance of a meteor was often considered an evil omen, betokening, for example, the death of a chief. On the other hand, if a meteor seems to approach one it is a good sign. Yet again they have other prophetic significance. 'Another ancestor is Tumatakohiri, who is seen at night. His appearance is that of a star flying through space. His task, as he so flies, is to foretell the aspect and conditions of the heavenly bodies, of winds, and of seasons. If he swoops downwards the following season will be a windy one. If he just flies through space, a fruitful season follows, a season of plenty lies before the people. That ancestor is a supernatural being, though really a star flying through space.'

Acknowledgements.—The author particularly wishes to express his indebtedness to the late Dr. J. K. H. Inglis of the Chemistry Department of the University of Otago for his great assistance with the many problems encountered in the analyses, and also for allowing that work to be carried out in his laboratories. His thanks are also extended to Drs. W. N. Benson and F. J. Turner for their guidance and advice in the setting up of this note; also to the Curator of the Otago University Museum, Dr. W. B. Benham, for permission to study the meteorite.

PROCEEDINGS
OF THE
MINERALOGICAL SOCIETY

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, Burlington House, London, W., January 24, 1935, *at* 4.30 *p.m.*

Sir THOMAS H. HOLLAND, F.R.S., President, in the Chair.

Mr. Charles Findlay Davidson, Dr. William Frederick Fleet, and r. Malcolm MacGregor were provisionally elected Ordinary Mem-ers of the Society. The resignation of Dr. George Sheppard was ccepted.

Reports were received from the Treasurer and the Editor.

An invitation was received from the Muséum National d'Histoire aturelle in Paris for delegates to attend the tercentenary celebrations the Museum from 24 to 29 June. It was resolved to ask the oreign Secretary to represent the Society.

GENERAL MEETING.

Held in the Apartments of the Geological Society, Burlington House, London, W., January 24, 1935, *at* 5.30 *p.m.*

Sir THOMAS H. HOLLAND, F.R.S., President, in the Chair.

Thirty-seven Members and five Visitors were present.

The elections of Mr. C. F. Davidson, Dr. W. F. Fleet, and Dr. M. acGregor as Ordinary Members of the Society were confirmed.

The President drew attention to the numerous exhibits which embers had brought as arranged for at the previous meeting. hese included:—

(1) Fine crystals of cassiterite from South-West Africa: ex-bited by Dr. H. F. Harwood.

(2) Silica-glass and fulgurites from the Libyan Desert, with otographs and lantern-slides: exhibited by Dr. L. J. Spencer.

(3) A cast and photographs of an australite from Lake Grace, estern Australia: exhibited by Dr. L. J. Spencer.

(4) A fine series of fluorite and associated minerals from localiti in Aberdeenshire and Banffshire: exhibited by Mr. Arthur Russell

The following papers were then read and discussed :—

1. Notes on the occurrence of fluorite in Aberdeenshire a Banffshire: by Mr. Arthur Russell.

2. On the occurrence of chondrodite in the Glenelg limestone Inverness-shire: by Prof. H. H. Read and Mr. I. S. Double (p. 84

3. Ankerites from the Northumberland coal-field: by Dr. Hawkes and Dr. J. A. Smythe (p. 65).

4. Apophyllite from Traprain Law, East Lothian: by Mr. J. G. Anderson and Mr. S. Elder (p. 90).

5. Studies on the zeolites. Part IX. Scolecite and metascolecit by Mr. M. H. Hey (p. 227).

6. A new apparatus for the determination of carbon dioxide: Mr. M. H. Hey (p. 76).

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, Burlington House London, W., March 14, 1935, *at* 4.30 *p.m.*

Sir Thomas H. Holland, F.R.S., President, in the Chair.

Prof. Edward Battersby Bailey, Mr. William Burton, Mr. W liam Colin Campbell Rose, and Mr. John Herbert Stanley were p visionally elected Ordinary Members of the Society. The resignat of Mr. Gilbert Greenwood was accepted.

A letter was received from Dr. A. E. Fersman thanking the Soci for having elected him an Honorary Member.

Reports were received from the Treasurer and the Editor.

Owing to the illness of the Foreign Secretary, Mr. Arthur Russ and Dr. G. F. Herbert Smith were appointed as the Society's de gates at the tercentenary celebrations of the Muséum Natio d'Histoire Naturelle in Paris in June.

It was agreed to circulate to members the recommendations of Nomenclature Committee and hold a discussion on the proposals the next General Meeting.

GENERAL MEETING.

Held in the Apartments of the Geological Society, Burlington House, London, W., March 14, 1935, *at* 5.30 *p.m.*

Sir THOMAS H. HOLLAND, F.R.S., President, in the Chair.

Forty-three Members and six Visitors were present.

The elections of Prof. E. B. Bailey, Mr. W. Burton, Mr. W. C. C. Rose, and Mr. J. H. Stanley as Ordinary Members of the Society were confirmed.

The following exhibits were explained:—

1. Native silver and argentite from the Kongsberg mines and other minerals from localities in southern Norway: exhibited by Dr. H. F. Harwood.

2. Synthetic spinels and cut specimens of the same recently described in some London newspapers as 'synthetic diamonds': exhibited by Mr. B. W. Anderson. Prof. W. T. Gordon sent some real diamonds from his collection for comparison.

3. A fine stalagmite of calcite from a cave at Cheddar, Mendip Hills: exhibited by Mr. Arthur Russell.

The following papers were then read and discussed:—

1. The late Palaeozoic quartz-dolerites and tholeiites of Scotland: by Dr. Frederick Walker (p. 131).

2. The rôle of kyanite in the 'hornfels zone' of the Carn Chuinneag granite (Ross-shire): by Prof. C. E. Tilley (p. 92).

3. A critical review of the data for a revision of the enstatite-hypersthene series: by Mr. R. Walls (p. 165).

4. Two new bismuth minerals from South Africa: by Prof. E. D. Mountain (read by Mr. F. A. Bannister) (p. 59).

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, Burlington House, London, W., June 6, 1935, *at* 4.0 *p.m.*

Mr. ARTHUR RUSSELL, Vice-President, and afterwards
Sir THOMAS H. HOLLAND, F.R.S., President, in the Chair.

Mrs. Virginia Courtauld, Mr. Arthur Charles Davy Pain, and Mr. William Hugill were provisionally elected Ordinary Members of the Society.

The death of Dr. Herbert H. Thomas on May 12, 1935, wa announced, and it was decided to send a letter of sympathy t Mrs. Thomas from the Society.

Reports were received from the Treasurer and the Editor. Th Editor read a letter from Sir Henry Miers and remarked that S Henry had been most helpful to him, having carefully read a proofs of the Magazine since 1900. The Secretary was instructe to send the thanks of the Society to Sir Henry.

The list of Officers and Members of Council for 1935–6 was con sidered, and it was decided that the four senior Ordinary Membe should retire, namely, Prof. P. G. H. Boswell, Prof. H. L. Bowma Dr. L. Hawkes, and Mr. J. B. Scrivenor. A further vacancy cause by the death of Dr. H. H. Thomas had also to be filled. Mr. Arthu Russell, Vice-President since 1932, was also due to retire from tha office. The following were proposed for submission to the Members as Vice-President, Prof. P. G. H. Boswell; as Ordinary Members o Council, Mr. A. Broughton Edge, Prof. H. H. Read, Mr. Arthu Russell, Mr. R. C. Spiller, and Dr. Gilbert Wilson.

The address to the Muséum National d'Histoire Naturelle in Par on the occasion of its tercentenary was read and approved. M Arthur Russell announced that he would not be able to go to Par as one of the Society's delegates on this occasion.

Dr. A. E. H. Tutton was appointed as the Society's delegate a the opening of the new building of the Geological Survey and Museu and at the celebration of the centenary of the Survey on July 3.

GENERAL MEETING.

Held in the Apartments of the Geological Society, Burlington House, London, W., June 6, 1935, *at* 5.30 *p.m.*

Sir Thomas H. Holland, F.R.S., President, in the Chair.

Forty Members and three Visitors were present.

The elections of Mrs. Virginia Courtauld, Mr. A. C. D. Pain, an Mr. W. Hugill as Ordinary Members of the Society were confirmed.

The following exhibits were explained:—

1. Stalactites and 'straw' stalactites from Winsor Hill quarry Shepton Mallet, Somerset, and cut specimens of silica-glass from th Libyan Desert: exhibited by Dr. L. J. Spencer.

2. Gem-stones cut from Devonshire fluorite, zinc-blende, an cassiterite: exhibited by Mr. E. P. Bottley.

Dr. L. J. Spencer opened a discussion on mineralogical nomenclature, in the course of which the General Secretary outlined the course of discussions carried on with the Mineralogical Society of America, and other members of the Society expressed their opinions on Dr. Spencer's proposals. No definite conclusion was arrived at.

The suggestions made in 1924 for international agreement in mineralogical and crystallographical nomenclature (Min. Mag., vol. 20, pp. 353–363) have not been realized, and it is now desirable to attempt to arrive at national agreement, and if possible for all English-speaking countries. The following list gives the names of minerals as at present adopted in the Magazine, the more important synonyms (in brackets) being entered as cross-references in the index:—

Felspar (feldspar)	Pyrite (iron-pyrites)
Scapolite (wernerite)	Chalcopyrite (copper-pyrites)
Olivine (peridot, chrysolite)	Mispickel (arsenopyrite)
Fibrolite (sillimanite)	Chalcosine (chalcocite)
Cyanite (cyanite)	Pyrrhotine (pyrrhotite)
Phenakite (phenacite)	Blende (zinc-blende, sphalerite)
Cordierite (iolite, dichroite)	Stibnite (antimonite)
Idocrase (vesuvianite)	Hemimorphite (calamine)
Nepheline (nephelite)	Smithsonite ($ZnCO_3$, calamine)
Analcime (analcite)	Chessylite (azurite)
Sphene (titanite)	Chalybite (siderite)
Anatase (octahedrite)	Haematite (hematite)
Baryte (barytes, barite)	Uraninite (pitchblende)
Fluorite (fluorspar)	Halite (rock-salt)

The following papers were then read and discussed:—

1. Metasomatism associated with the greenstone-hornfelses of Kenidjack and Botallack, Cornwall: by Prof. C. E. Tilley (p. 181).

2. The chemical composition and crystal-structure of ettringite: by Mr. J. D. Bernal and Mr. F. A. Bannister.

3. Anomalies in the analytical determination of water in epidote: by the Rev. A. F. Smethurst (p. 173).

4. Some data on the iron-rich hypersthenes: by N. F. M. Henry (p. 221).

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, Burlington House, London, W., November 14, 1935, *at* 4 *p.m.*

Sir Thomas H. Holland, F.R.S., President, in the Chair.

The following deaths were reported: Prof. Edward Salisbury Dana, Honorary Member since 1897, died June 16, 1935; Mr. James

Broadhead, died July 13, 1935; and Mr. Francis Henry Butler, di August 19, 1935.

Dr. Gordon Frank Claringbull, Mr. Henry Stantley Lawies Jacksc and the Rev. Arthur Frederick Smethurst were provisionally elect Ordinary Members of the Society.

Reports were received from the Treasurer and the Editor.

Mr. T. Crook and Dr. W. R. Jones were appointed auditors f the accounts.

The draft Annual Report was read and after amendment approve It was decided to hold the meetings in 1936 on Thursdays, January 3 March 26, June 25, and November 5.

GENERAL (ANNIVERSARY) MEETING.

Held in the Apartments of the Geological Society, Burlington House, London, W., November 14, 1935, *at* 5.30 *p.m.*

Sir THOMAS H. HOLLAND, F.R.S., President, in the Chair.

Thirty-seven Members and seven Visitors were present.

The chairman nominated Dr. Malcolm MacGregor and Mr. C. Davidson to act as scrutineers of the voting-papers for the electi of Officers and Council.

The elections of Dr. G. F. Claringbull, Mr. H. S. L. Jackson, a the Rev. A. F. Smethurst as Ordinary Members of the Society we confirmed.

The General Secretary then read the following:—

ANNUAL REPORT OF COUNCIL FOR 1934–1935.

During the session 1934–5 there have been four ordinary meetings a nineteen papers have been read. Brief abstracts of papers to be read have be circulated to members before the meetings instead of the card giving titles onl and special exhibits of specimens have been on view at each meeting. The tot attendance at the four meetings was 169.

At the meeting in June a discussion on mineralogical nomenclature was open by Dr. L. J. Spencer, who advocated agreement among the English-speaki countries, and proceeded to give a selected list of names as at present adopt in the Mineralogical Magazine for minerals having two or more current alt native names. His list was as follows:—Analcime, anatase, baryte, blende (zi blende), chalcopyrite, chalcosine, chalybite, chessylite, cordierite, felsp fibrolite, fluorite, haematite, halite, hemimorphite, idocrase, kyanite, mispick nepheline, olivine, phenakite, pyrite, pyrrhotine, scapolite, smithsonite, sphe stibnite, uraninite. The General Secretary outlined the course of discussio carried on chiefly by correspondence with the committee of the Mineralogic Society of America, and various members expressed their opinions of Dr. Spence

roposals. Many members in particular preferred azurite to chessylite, chalcote to chalcosine, siderite to chalybite, pyrrhotite to pyrrhotine, arsenopyrite mispickel, and sillimanite to fibrolite.

The Council regrets to record the deaths of one Honorary Member, Professor dward Salisbury Dana, and of four Ordinary Members: James Broadhead; rancis Henry Butler, a Life Member since 1885; James Malcolm Maclaren; nd Herbert Henry Thomas, a past Vice-President, and for fourteen years a ember of the Council.

Three Ordinary Members have resigned. One Honorary Member, Dr. A. E. ersman, and ten Ordinary Members have been elected, bringing the total embership on October 31, 1935, to 236, including eight Honorary Members.

During the year there have been issued four numbers of the Magazine (nos. 147–50), containing 17 papers occupying 180 pages, with 36 pages of proceedings, ve-laws, and list of members, 22 text-figures, and 5 plates. Mineralogical bstracts published with these numbers occupied 144 pages, containing 499 ostracts. Number 147 of the Magazine consisted of the index to volume 23 of e Magazine and volume 5 of the Abstracts, containing about 12,000 entries nd occupying 118 pages. This was compiled by the Editor, Dr. L. J. Spencer.

The accounts for the year ending December 31, 1934, showed an excess of sets over liabilities of £1247 10*s*. 4*d*. against £1151 12*s*. 11*d*. on December 30, 53. These assets do not include the Library and unsold stock of publications, r the securities allocated to the Composition Fees Account. The value of the curities standing in the names of the Trustees on December 31, 1934, was, neral Reserve £990 0*s*. 8*d*., Composition Fees Account £1081 12*s*. 7*d*., against 74 14*s*. 3*d*. and £987 3*s*. 9*d*., respectively, on December 30, 1933. During the year 8*s*. 0*d*. Metropolitan Water Board 3% 'B' Stock, inscribed, was purchased r addition to the General Reserve, and £10 12*s*. 0*d*. of that stock and £10 4*s*. 8*d*. Conversion Loan 1948/53 inscribed Stock for the Composition Fees Account.

The Society's Library has received during the year 125 parts of periodicals, d 15 separate copies of papers. 35 parts or volumes have been borrowed.

At the invitation of Professor C. E. Tilley members of the Society paid a visit the new laboratories of the Department of Mineralogy and Petrology at Cambridge on Saturday, June 15. There were present Sir John S. Flett and Dr. E. H. Tutton, past-Presidents, sixteen members, and eight guests. Parties re conducted through the laboratories and the museum by members of the staff the Department, and demonstrations were given, particularly of apparatus ed in the measurement of physical properties and for the construction of crystal dels. The visitors were entertained to tea by the Professor and Mrs. Tilley. vote of thanks proposed by Dr. Tutton was passed with an enthusiasm indicae of the interesting afternoon which all enjoyed.

Dr. G. F. Herbert Smith acted as the Society's delegate at the tercentenary lebrations of the Muséum National d'Histoire Naturelle in Paris, and presented address from the Society. Dr. A. E. H. Tutton represented the Society at celebration of the centenary of the Geological Survey of Great Britain and the opening of the new building of the Geological Survey and Museum.

The adoption of the report having been proposed from the Chair d seconded by Prof. C. G. Cullis was carried unanimously.

A vote of thanks to the Geological Society for allowing the u of its apartments was proposed by Mr. R. C. Spiller and seconded b Mr. E. P. Bottley and carried unanimously.

The scrutineers reported that 58 voting-papers for the Officers a Council for the ensuing year had been received and that the li nominated by the Council had been approved. The President declar these Officers and Ordinary Members of Council elected :—

President. Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.S LL.D., F.R.S.

Vice-Presidents. Sir William H. Bragg, O.M., K.B.E., M.A., D.S F.R.S.

Prof. P. G. H. Boswell, O.B.E., D.Sc., A.R.C.S F.R.S.

Treasurer. F. N. Ashcroft, M.A., F.G.S., F.C.S.

General Secretary. W. Campbell Smith, M.C., T.D., M.A., F.G.S.

Foreign Secretary. Prof. A. Hutchinson, O.B.E., M.A., Ph.D., F.R.

Editor of the Journal. Dr. L. J. Spencer, C.B.E., M.A., Sc.D., F.R.

Ordinary Members of Council.

T. Crook, A.R.C.S.I., F.G.S.
Dr. W. F. P. McLintock, D.Sc., F.G.S.
L. R. Wager, B.A., B.Sc., F.G.S.
A. K. Wells, D.Sc., F.G.S.
Prof. A. Brammall, Ph.D., D.Sc., F.G.S.
C. W. Mathews, F.G.S.
Dr. T. C. Phemister, Sc.M., Ph.
A. Broughton Edge, M.B.I A.R.S.M., F.G.S.
Prof. H. H. Read, D.Sc., F.G.S.
Arthur Russell, M.B.E.
R. C. Spiller, M.A.
Gilbert Wilson, Ph.D. M.S F.G.S.

Sir Albert Kitson proposed a vote of thanks to Mr. Arthur Russe retiring from the office of Vice-President, and to the three retiri Ordinary Members of Council, Prof. H. L. Bowman, Dr. L. Hawke and Mr. J. B. Scrivenor. This was seconded by Dr. H. F. Harwo and carried unanimously.

The following exhibits were explained :—

1. Synthetic sapphires : exhibited by Dr. A. T. J. Dollar.

2. Scapolite, rough and cut, from Minas Geraes, Brazil : exhibit by Mr. E. P. Bottley.

3. A selection of specimens from recent finds of Swiss minera and photographs of their localities. The specimens shown includ

atolite from the Scopi massif (the first authentic occurrence in witzerland); phenakite from the Griessernthal, Maderanerthal (the ird recorded occurrence in Switzerland); sphene and prehnite from arious occurrences on the slopes of Piz Vitgira, Piz del Laiblau, and iz del Ufiern in the Val Nalps; axinite from the cliffs on the west de of the Glacier de Nalps, Val Nalps; and sphene and adularia om the cliffs of the Pazzolastock near Tschamut: exhibited by r. F. N. Ashcroft.

The following papers were then read and discussed:—

1. Cassiterite crystals of distorted habit from the Pilbara goldfield, Vestern Australia: by Dr. Edward S. Simpson (read by Dr. L. J. pencer).

2. An X-ray examination of substituted edingtonite: by Mr. W. H. aylor (p. 208).

3. Some unusual gem spinels from Ceylon: by Mr. B. W. Anderson nd Mr. C. J. Payne.

MINERALOGICA

ABSTRACT OF RECEIPTS AND PAYMENT

GENERAL PU

Receipts.	£ s. d.	£ s.
By Balances brought forward from 1934—		
1. At Bankers:		
(*a*) Current Account	14 1 0	
(*b*) Deposit Account	200 0 0	
2. In Office	0 7 5	
		214 8
Entrance Fees		12 12
Annual Subscriptions—		
1. Current year	180 12 0	
2. Arrears	2 2 0	
3. Advance	10 10 0	
		193 4
Sale of Publications—		
1. By Publishers, April 1, 1934–March 31, 1935. Sales at subscription rate £214 0*s.* 0*d.* and other sales £37 15*s.* 6*d.*, less trade discount and commission £66 1*s.* 10*d.*, and distribution charges £10 17*s.* 3*d.*	174 16 5	
2. By Custodian of Stock, 1935. £16 14*s.* 6*d.*, less distribution charges £2 1*s.* 4*d.*	14 13 2	
		189 9
Advertisement Fees, £21 19*s.* 1*d.*, less commission £4 7*s.* 10*d.*		17 11
Interest on Investments as received—		
1. £640 3½% War Loan 1952 and after, Inscribed Stock	22 8 0	
2. £105 4% Consolidated Loan 1957, Inscribed Stock	4 4 0	
3. £100 4% Funding Loan 1960–90, Inscribed Stock	4 0 0	
4. £50 8*s.* 0*d.* Metropolitan Water Board 3% 'B' Stock, Inscribed	1 10 2	
		32 2
Deposit Interest		1 13
Small Receipts		0 16
Transfers from other accounts—		
From Composition Fees Account, being Interest on Investments		34 14
		£696 12

OCIETY

OR THE YEAR ENDING DECEMBER 31, 1935

OSES ACCOUNT

Payments.	£ s. d.	£ s. d.
Printing and distributing the Mineralogical Magazine Nos. 148–151 inclusive (Oxford University Press)—		
1. Printing	310 3 6	
2. Illustrations	32 18 0	
3. Authors' Separate Copies	31 7 0	
4. Distribution Charges	14 10 0	
5. Postal Wrappers (renewal of stock)	2 4 6	
		391 3 0
Printing and distributing Notices of Meetings and other annual miscellaneous printing		17 14 0
Miscellaneous Printing, &c. (not annual)—		
1. Notice of visit to Cambridge	0 18 6	
2. List of Members, &c. (wrapper for)	1 17 6	
		2 16 0
Expenses at Meetings—		
1. Operator of lantern	1 11 6	
2. Porter	1 0 0	
3. Tea	3 14 6	
		6 6 0
Care of Stock of Publications, J. Mugford, Annual Fee		1 1 0
Editor's Honorarium		50 0 0
Librarian's Honorarium		5 0 0
Stationery		4 3 6
Address to the Muséum National d'Histoire Naturelle, Paris (tercentenary)		2 11 0
Advertisement of the Mineralogical Magazine		1 1 0
Postage—		
1. Hon. Secretary	0 19 0	
2. Editor	0 17 0	
3. Librarian	0 1 6	
4. Hon. Treasurer (not charged)	0 0 0	
		1 17 6
Bank charges and other small items		0 8 7
Balance, December 31, 1935—		
1. At Bankers:		
(*a*) Current Account	12 9 6	
(*b*) Deposit Account	200 0 0	
2. In Office	0 1 0	
		212 10 6
		£696 12 1

Examined and compared with vouchers and found correct.

W. R. JONES
THOS. CROOK } Auditors.

January 24, 1936.

F. N. ASHCROFT, Hon. Treasurer.

BALANC

DECEMBI

LIABILITIES.	£ s. d.	£ s.
To Annual Subscriptions received in advance—		
Received in 1935 for 1936		10 10
Excess of Assets over Liabilities		1250 13
		£1261 3

COMPOSITION FEES ACCOUN

RECEIPTS.	£ s. d.	£ s.
By Composition Fees received as per last Account . . .		1149 15
Income—		
Interest on Investments as received:		
1. £975 3½% War Loan 1952 and after, Inscribed Stock	34 2 6	
2. £10 4*s.* 8*d.* 3% Conversion Loan 1948–53, Inscribed Stock	0 6 0	
3. £10 12*s.* 0*d.* Metropolitan Water Board 3% 'B' Stock, Inscribed	0 6 4	
		34 14
		£1184 9

SHEET

31, 1935.

Assets.	£ s. d.	£ s. d.
By Balances—		
1. At Bankers:		
(*a*) Current Account	12 9 6	
(*b*) Deposit Account	200 0 0	
2. In Office	0 1 0	
		212 10 6
Sundry Debtors—		
1. Publishers (Oxford University Press):		
(*a*) For sales of Publications, April 1–Dec. 31, 1935	50 8 2	
(*b*) For advertisement Fees, April 1–Dec. 31, 1935	12 3 2	
2. For Sales of Publications by Custodian	12 3 0	
		74 14 4
Investments at Broker's Valuation—		
1. £640 3½ % War Loan 1952 and after, Inscribed Stock, at 106⅛ %	679 4 0	
2. £105 4 % Consolidated Loan 1957, Inscribed Stock, at 114¾ % ex div.	120 9 9	
3. £100 4 % Funding Loan 1960–90, Inscribed Stock, at 117⅜ %	117 7 6	
4. £50 8*s.* 0*d.* Metropolitan Water Board 3% 'B' Stock, Inscribed, at 98¼ %	49 10 4	
		966 11 7
Annual Subscriptions in arrear (£10 13*s.* 0*d.*) estimated to realize		6 6 0
Entrance Fee in arrear		1 1 0
		£1261 3 5

Note.—The value of the Library, that of the unsold Stock of Publications, and the Securities allocated to the Composition Fees Account are not included in the above assets.

January 24, 1936. F. N. ASHCROFT, Hon. Treasurer.

YEAR ENDING DECEMBER 31, 1935

Payments.	£ s. d.	£ s. d.
To Investments as per last Account—		
1. £975 3½ % War Loan 1952 and after, Inscribed Stock, valued by Brokers at £1034 14*s.* 4*d.* (106⅛ %), at cost	1128 15 0	
2. £10 4*s.* 8*d.* 3 % Conversion Loan 1948–53, Inscribed Stock, valued by Brokers at £10 14*s.* 5*d.* (104¾ %), at cost	10 10 0	
3. £10 12*s.* 0*d.* Metropolitan Water Board 3 % 'B' Stock, Inscribed, valued by Brokers at £10 8*s.* 3*d.* (98¼ %), at cost	10 10 0	
		1149 15 0
Income transferred to General Purposes Account		34 14 10
		£1184 9 10

Examined and compared with Vouchers and found correct.

W. R. JONES
THOS. CROOK } Auditors.

January 24, 1936. F. N. ASHCROFT, Hon. Treasurer.

MINERALOGICAL ABSTRACTS

(Vol. 6, No. 5, March, 1936.)

Notices of Books.

WKINS (Alfred C.). *The book of minerals.* New York (John Wiley & Sons) and London (Chapman & Hall), 1935, xii + 161 pp., 1 pl., 67 text-figs. Price \$1·50 = 7*s.* 6*d.*

This book discusses, in a clear simple style, the fundamental facts ıcerning the common minerals and their manner of formation. e technical treatment which characterizes practically all books in ıeralogy has purposely been avoided, with the result that the hor has been able to produce an attractive little volume which uld appeal to a large mass of readers whose interest in this ject has, too long, been neglected. The amateur collector, the mbers of scout organizations, and young people everywhere whose iosity regarding minerals and rocks has been aroused, will find book understandable and inspiring. In addition to a well sen bibliography for those who wish further information about erals, and a good index, the general discussion follows five main ds: Some facts about minerals; For those interested in crystals; hods of making unknown minerals disclose their identity; Find- minerals; Description of mineral species. The book is printed excellent paper and contains many satisfactory photographs of the mon minerals. A. P. HONESS.

SMAN (A. E.). *The scientific study of Soviet mineral resources.* Edited by C. P. DUTT. New York (International Publishers), [1935], 149 pp., 17 pls., 4 text-figs. Price 4 rubles (bound 5 rubles).

an enthusiastic account is given of the intensive work that has in ent years been energetically carried on, largely under the leader- of the author, into the mineral resources of a vast territory 000,000 sq. km.). New research institutions have been founded connexion with the Academy of Sciences, and expeditions have n sent to distant regions. The problems have been attacked n a theoretical geochemical point of view, and it is found that ny of the more important mineral deposits lie at the intersection different systems of orogenic folding. Several new deposits of

economic importance have been discovered. It is stated that duri the last ten years about forty-two new mineral species (eleven p cent. of the total number mentioned in the world's literature) ha been described by Soviet workers. The volume has been printed Russia; it is well printed and written, but contains some misprin Portraits are given of M. V. Lomonosov (1711–1765), D. S. Me deleyev (1834–1907), V. I. Vernadsky (1863), V. A. Obruchev (186 F. J. Loewinson-Lessing (1861), A. V. Shubnikov (1887), and F. Chernyshev (1856–1914). L. J. S.

Schmidt (Walter) & Baier (E.). *Lehrbuch der Mineralogie.* Ber (Borntraeger), 1935, vi + 320 pp., 1 coloured plate, 214 te figs. Price 14 RM. bound, less 25 % foreign.

This elementary text-book on mineralogy is based on the lectu given by the authors in the Technical High School in Berlin. H of the volume is devoted to general principles and half to an acco of the more common minerals. New ideas of structure are brou in and the treatment of the subject shows a marked deviation fr the old style of text-book. The book is very clearly printed good paper, and there is an excellent series of text-figures. L. J. S

Buttgenbach (H.). *Les minéraux et les roches.* 6e édition. P (Dunod) & Liége (Vaillant-Carmanne), 1935, xii + 730 pp., 4 p 609 text-figs.

The sixth edition of this successful text-book is 35 pages sho than the fifth edition of 1928 [M.A. 3–462]. The matter has b in part rearranged and there are new chapters on crystalline struct and radioactivity. New diagrams with $Na_2O - K_2O - CaO$ trian set at different levels along a prism illustrate very simply the lations between different kinds of igneous rocks. Several us reference tables are given of the numerical data of minerals.

L. J. S

Precious Stones.

Willemse (A.). *De edelsteenen. Herkenning, beoordeeling en w deschatting door eenvoudige middelen voor juweliers en hebbers.* Eeckeren, 1935, 112 pp., 14 figs.

This small book, written in Flemish, gives briefly the usual in ductory matter relating to hardness, specific gravity, refrac indices, lustre, and forms of cutting. A special point is made of forms of inclusions in natural and artificial stones as seen under

icroscope, and several of the text-figures are rough drawings of ese inclusions, one of them showing liquid inclusions with bubbles the new artificial emerald ('igmerald'). In the descriptive portion e different kinds of stones are described in the order of their colour hich of course means considerable repetition)—white (glass, dia-ond, &c.), red, blue, green, yellow and yellow-brown, grey and lack, and iridescent stones (opal, cat's-eye, moonstone, &c.).

L. J. S.

OWARD (J. Harry). *Handbook for the amateur lapidary.* Greenville, S.C. (J. H. Howard), 1935, 140 pp., 44 figs. Price $2.00.

This is really a second and much enlarged edition of the author's The working of semi-precious stones', 1931 [M.A. **5**–54]. It is ritten for amateurs by an amateur, who himself has had difficulty finding much published information and no book on the subject f. M.A. **6**–6]. He has therefore worked out his own methods by al and error, and devised and made his own tools and gadgets. uline sketches are given of these appliances, and many useful rinkles on matters of detail are given for the benefit of the amateur o has tried and failed. Chapters are devoted to the sawing of nes (with the diamond-charged disk and the cheaper method 'mud sawing' with carborundum), cabochon cutting, grinding d polishing large flat surfaces, drilling stones, bead making, cutting eted gems (for this the author has devised a form of two-circle achine), mosaics, carving and engraving, diamond polishing, &c. the chapter on optics the relation that the angles of the facets ould bear to the refractive index of the stone is determined by graphical method. Other chapters give miscellaneous data and formation, and sources of supply (in America) for equipment and aterial.

L. J. S.

VANS (Joan) & SERJEANTSON (Mary S.). *English mediaeval lapidaries.* Early English Text Society, no. 190, London (Humphrey Milford, Oxford University Press), 1933, xii + 205 pp., 1 pl. Price 16*s.*

These lapidaries (i.e. treatises on precious stones) are now printed r the first time. The earliest is an eleventh-century MS. giving short account of the twelve apocalyptic stones; it is based on the ritings of Isidore of Seville (*c.* 560–636) and Bede (673–735), and the earliest known vernacular lapidary in western Europe (British useum, Cotton MS.). Of the five fifteenth-century MSS., the most portant is one in Peterborough Cathedral in which 145 stones are

noted under separate headings; this is based on 'De proprietatib rerum' of Bartholomaeus Anglicus (*fl.* 1230–1250) and the Angl Norman Lapidary. Lastly, a sixteenth-century MS. in the collecti of Sir Hans Sloane (British Museum), which is a free translation the second Anglo-Norman Lapidary written before 1243. Li many modern books on precious stones, these are the productic of scribes copying one from another. The following item in t Sloane MSS. is good to quote:

EMERAUDE. It is greene & cometh from the Streame of Paradis And of Si Those of Siria are ye best. This stone multiplieth a mans goods; if he ber on him & keepe it cleane, it maketh him to be of word & fortune wyse.

L. J. S.

HEATHER (P. J.). *Precious stones in the Middle-English verse of fourteenth century.* Folk-Lore (Trans. Folk-Lore Soc. Londo 1931, vol. 42, pp. 217–264, 345–404.

Quotations with notes are given from Chaucer and other auth of the period, grouped under the headings: stones and nature, he ing, magic, the individual, buildings, clothing, crowns and rings. a armour. L. J. S.

Gemstones. The mineral industry of the British Empire and forei countries. Imperial Institute, London (H.M. Stationery Offic 1934, 137 pp. Price 2*s.* 6*d.* [M.A. **5**–396.]

The first issue of this moderately priced handbook became hausted within a few months. The present issue is a reprint w the addition of statistics of production for 1933 in a few of tables. L. J. S.

STUTZER (O.) & EPPLER (W. Fr.). *Die Lagerstätten der Edelste und Schmucksteine.* Die wichtigsten Lagerstätten der „Nic Erze", vol. 6, Berlin (Borntraeger), 1935, xvii + 567 pp., 1 figs. Price 45.50 Mk. [£3 12*s.*].

This work by O. Stutzer on the more important deposits of n metallic minerals first appeared in two parts in 1911 and 1914, a since 1931 a second edition has been in progress in a series of volum I, oil; II, coal; III, salt (in preparation); IV, phosphates a nitrates; V, sulphur and graphite, iodine and boron, magnesite a talc; VI, diamond, precious and ornamental stones. The to price of the five volumes that have yet been issued is 214 ma (£17 11*s.* at the present rate of exchange), a price sufficiently h

hinder circulation, especially of books which after all are merely mpilations. Like most recent books on precious stones, the resent volume takes much of the material as well as several illustra- ons from the standard work of Max Bauer. Special emphasis is re, however, given to the modes of occurrence of each mineral the several known localities. The first part (pp. 1–216) by . Stutzer deals with diamond; and the second part (pp. 217–540) W. F. Eppler on other precious stones repeats much of the in- rmation in the same author's recent book [M.A. **6**–5].

L. J. S.

ternationale Bezeichnungsübersicht handelszulässiger Benennungen der Edelsteine, Schmucksteine, Synthesen, Dubletten, Imitationen sowie der Perlen.—International nomenclature of admissible trade names of precious and semi-precious stones, synthetics, doublets, imitations and of pearls. [Title also in French and Italian.] Den Haag (B.I.B.O.A. = Bureau international des associations de fabricants, grossistes et détaillants de joaillerie, bijouterie, orfèvrerie et argenterie, Publ. no. 8), 1935, [46 pages unnumbered], oblong 30 × 23 cm. Price 4 Fl.

This is a noteworthy and praiseworthy attempt to bring some der into the confused nomenclature of precious stones as at present ed in the trade. Initiated by a group of German trade organiza- ons and approved by the International Congress of Jewellers, it has en drawn up by K. Schlossmacher and G. Göbel with the assistance collaborators in various countries and finally published by the menclature committee of the 'B.I.B.O.A.'. The matter is set out tabular form in four languages (German, English, French, and alian) under the several mineral species in order of their importance gemstones, giving the colours, hardness, specific gravity, and fractive indices of each. The result is somewhat involved and ference to the awkward shaped tables is none too easy; while to ersons not well acquainted with the true mineralogical bearing the subject and using names they evidently do not understand ere is rather a danger of introducing still further confusion. Ap- oved names are printed in black in the four languages, while merous ambiguous and misleading names placed on the black list e printed in red. The former conform more or less closely with ineralogical nomenclature, but there are still several terms that ould be banned; e.g. 'Topaz-Quartz' (Engl.) and 'Quartztopaz'

(Fr.) for citrine, and 'Olivinegarnet' (Engl.) and 'Grenat olivine' (Fr.) for demantoid. The English, French, and Italian texts have evidently been translated from the German and they contain many comical errors; e.g. 'Manganese Gravel' (Engl.) for Mangankiesel (rhodonite), 'Feldspato di Zinco' (Ital.) for Zinkspat (smithsonite). 'Padparadscha' (an admissible trade-name) is given as three variants, all of them strange distortions of the Sinhalese 'padma raga', meaning lotus colour. L. J. S.

Gemmological News. Official Journal of the Gemmological Association of the National Association of Goldsmiths. London (W. J. S. & O.), 1935, monthly parts.

From October 1931 to October 1934 'The Gemmologist' [M.A. 5–53] acted as the official organ of the Gemmological Association. This patronage has since January 1935 been transferred to the 'Watchmaker & Jeweller, Silversmith & Optician', a monthly trade journal of long standing. Each issue of this now contains a section of 4 to 6 quarto pages headed 'Gemmological News'. These pages, together with a liberal allowance of advertisements, are issued separately each month as unnumbered parts and without pagination, and there is no indication that they are reprints from another journal. In addition to reports of the meetings and examinations of the association, this new periodical contains a number of articles of a popular character and notes on items of trade interest.

L. J. S.

Gems & Gemology. Los Angeles, Calif. (The American Gem Society), 1934–35, vol. 1, nos. 1–12, 368 pp., figs.

This new periodical, issued every two months in a loose-leaf form, is the official organ of the American Gem Society and the Gemological Institute of America, both of which are located in Los Angeles and under the direction of Robert M. Shipley, who has done intensive work in promoting a general knowledge of gemstones. It contains, amongst other matter, a series of articles on the important diamonds of the world. L. J. S.

Some facts about precious stones. London (London Chamber of Commerce, Diamond, Pearl & Precious Stones Trade Section) [1935], 16 pp.

This pamphlet has reference to the conflict of trade interests between native gemstones and those produced artificially 'by the

tervention of man'. The latter are asserted to be not real or nuine [but they have grown according to the natural laws of ystallization]. L. J. S.

RAUNS (R.). *Schmucksteine.* Handwörterbuch der Naturwissenschaften, 2nd edition, Jena, 1933, vol. 8, pp. 1069–1108, 8 figs.

A general account of precious stones under the headings: general, ineral species, and artificial stones. L. J. S.

ANNISTER (F. A.). *Atomic groupings in gem stones.* Gemmologist, London, 1934, vol. 4, pp. 138–146, 5 figs.

The structure of diamond is explained. All other gemstones ntain 44 to 58 % of oxygen, which has a controlling influence on e structure; and with increasing amount there is a more or less gular decrease in the hardness and refractive index. The different pes of silicate structures are mentioned. L. J. S.

ANNISTER (F. A.). *Glass imitation gems.* Gemmologist, London, 1934, vol. 4, pp. 37–43, 1 fig.

Data relating to various types of glass given in an earlier paper [Min. Mag. **22**–136] are presented from the point of view of imitation ms, and minor additions are made to the plotted graph.

L. J. S.

AYNE (C. J.). *Dispersion of gemstones.* Gemmologist, London, 1935, vol. 4, pp. 263–265.

The following values were obtained for the refractive indices (Na) nd dispersion (Li 6708 Å. to cyanogen 4216 Å.; for the blende Li Ba 4554 Å.). The spinel examined was artificial colourless 'corundolite', sp. gr. 3·617–3·625, which had been fraudulently offered as rtificial diamond.

	n.	ϵ.	ω.	Dispersion.
Quartz	—	1·5534	1·5442	0·0144
Spinel	1·7275	—	—	0·0203
Zircon (yellow)	—	1·9850	1·9265	0·0396
Flint-glass	1·6250	—	—	0·0418
Diamond	2·4175	—	—	0·0452
Blende	2·3710	—	—	0·1248

Remarks are added on the angles of the facets of brilliant-cut iamonds. L. J. S.

Eppler [W. F.]. *Der synthetische Smaragd.* Deutsche Goldschmiede Zeitung, 1935, no. 15, (reprint 3 pp.), 5 figs.

Anderson (B. W.). *Igmerald—the German synthetic emerald.* Gemmologist, London, 1935, vol. 4, pp. 295–300, 3 figs.

Artificial emerald ('igmerald') prepared by the I. G. Farben industrie of Bitterfeld is said to have the form of prismatic crystal up to 1 cm. long, but only small cut stones have been available for examination. These have all the appearance of natural emerald but they have a slightly lower density (2·662; 2·66) and refractive indices (ω 1·5644, ϵ 1·5606; ω 1·5660, ϵ 1·5647), and much lower birefringence (0·0038; 0·0013). Dichroism is strong, yellowish green and dark bluish-green, and the birefringence uneven due to strain. The absorption spectrum shows bands due to chromium. Reticulated lines are marked out by minute liquid inclusions. The method of manufacture and the chemical composition are not stated. [Cf. M.A. **3**-441.] L. J. S.

Amstutz (A.) & Borloz (A). *Note préliminaire sur la synthèse de l'émeraude.* Compt. Rend. Soc. Physique Hist. Nat. Genève 1935, vol. 52, pp. 39–41, 2 figs.

A saturated solution of SiO_2, BeO, and Al_2O_3 with a trace of Cr_2O_3 in fused BeF_2 yields a crop of minute crystals of emerald as the BeF_2 volatilizes. Larger crystals were obtained by allowing a mixture of these materials to fall periodically on a small crystal in an electric furnace. Another method of growing larger crystals is in two connected platinum vessels containing fused BeF_2, one at a lower temperature and containing fragments of beryl to be dissolved in the melt, and the other at a rather higher temperature with slow vaporization of the BeF_2, which circulates in the apparatus and acts as a mineralizer. L. J. S.

Nath (N. S. Nagendra). *The dynamical theory of the diamond lattice. I.* Proc. Indian Acad. Sci., 1934, vol. 1, sect. A. pp. 333–345, 2 figs.

—— —— *Part II. The elastic constants of diamond.* Ibid., 1935, vol. 1, sect. A, pp. 841–849, 4 figs.

—— —— *Part III. The diamond-graphite transformation.* Ibid. 1935, vol. 2, sect. A, pp. 143–152, 5 figs.

Mathematical equations are given for the vibratory motions of the diamond lattice. This vibration is Raman-active, but optically inactive. The elastic constants are calculated and plotted on the

fferent crystal planes. The transformation of diamond to graphite hen heated is explained by a relative displacement of the two face-ntred lattices together with expansion and gliding. L. J. S.

IMBALL (George E.). *The electronic structure of diamond.* Journ. Chem. Physics (Amer. Inst. Physics), 1935, vol. 3, pp. 560–564, 3 figs.

The energy levels of the carbon atom are broadened into bands milar to energy bands in metals. The 2*s* level of the atom splits to two bands and the 2*p* level into six bands. The 2*s* bands and e two lowest of the 2*p* bands are completely filled by electrons. ne lack of electrical conductivity is explained and other properties diamond are discussed. L. J. S.

FLOßMACHER (K.) & KLANG (H.). *Der Maxixeberyll. I.* Zentr. Min., Abt. A, 1935, pp. 37–44, 6 figs.

A blue alkali-beryl of gem quality [M.A. **5**–295] has been found th pink tourmaline in alluvium in the Maxixe mine, Piauhy strict, south of the Rio Arassuahy, NE. Minas Geraes. The corroded asses show etch-figures, and also channels parallel to the *c*-axis. e colour and pleochroism are striking: viewed in the direction of e *c*-axis the colour is a fine blue, while perpendicular thereto is nost colourless. The pleochroism, ω cobalt-blue, ϵ colourless, the reverse of that shown by other blue beryls. On exposure to ylight for a few days, or when heated, the colour fades to yellow-n. $D_4^{17.5}$ 2·805.

ϵ 1·58075 (λ 7000), 1·58442(Na), 1·59471 (λ 4392 Å.);
ω 1·58818 (λ 7000), 1·59203(Na), 1·60251 (λ 4392). L. J. S.

DEBLING (W.) & TROMMAU (H. W.). *Maxixeberyll. II. Analyse und Beiträge zur Trennung Beryllium–Aluminium und den Alkalien.* Zentr. Min., Abt. A, 1935, pp. 134–139.

Analysis of this beryl [M.A. **5**–295] gave SiO_2 62·52, Al_2O_3 18·08, O 11·30, Fe_2O_3 0·03, MgO 0·25, CaO 0·22, CuO trace, Li_2O 0·98, a_2O 1·28, Cs_2O 2·80, B_2O_3 0·39, ign. 2·20 = 100·05. Separation of ryllium and aluminium by the methods with ether + HCl, oxy-inoline, and guanidine carbonate gave concordant results.

L. J. S.

RAUNS (R.). *Ein außergewöhnlich schönes Stück von Lasurstein.* Centr. Min., Abt., 1933, pp. 295–297, 1 fig.

A fine block (6·25 kg.) of lapis-lazuli, probably from Lake Baikal, ows large rhombic-dodecahedral crystals (up to 2·7 cm. across) of

deep blue lazurite embedded in a matrix of calcite, colourles diopside, and mica. The lazurite crystals show minute specks c pyrite and in thin section are seen to enclose much diopsid but only little calcite. Their high density, 2·8 (as contrasted wit 2·38–2·45 for pure lazurite), is due to these enclosures. L. J. S.

Anderson (B. W.) & Payne (C. J.). *Specific gravity of lapis lazul* Nature, London, 1934, vol. 134, p. 627; Gemmologist, Londo 1934, vol. 4, pp. 124–126.

More than 500 representative specimens of lapis-lazuli from variou localities gave sp. gr. 2·45–2·94, the majority (95 %) giving 2·75–2·9 Thin sections show the presence of pyrite, amphibole, and only litt calcite. These values agree with those (2·76–2·95) given by M. Brisson in 1787, but not with those (2·38–2·45) quoted in curre text-books. This 'error' is due to A. Breithaupt (1847) [but he there is a confusion between the mineral lazurite and the lazuri rock = lapis-lazuli]. L. J. S.

Spencer (L. J.). *Pollucite, a new gem stone.* Gemmologist, Londo 1934, vol. 3, pp. 263–264.

Clear colourless pollucite ($H_2Cs_4Al_4(SiO_3)_9$) with H. $6\frac{1}{2}$, sp. gr. 2·8 n 1·51, from pegmatite at Newry, Oxford Co., Maine, U.S.A., h been cut as a faceted gemstone, adding one more to the long list silicate minerals suitable for this purpose. L. J. S.

Mayer (Fritz K.). *Röntgenographische Untersuchungen an Türkisc* Chem. der Erde, 1935, vol. 9, pp. 311–317, 1 fig.

Jung (Hermann). *Zur röntgenographischen Untersuchung an Türk und anderen Phosphaten.* Ibid., pp. 318–319.

X-ray powder photographs of turquoise (d 2·687–2·815) fro several localities and of artificial turquoise (d 2·46–3·173) sho similar patterns. A somewhat similar pattern is shown by wavelli and chalcosiderite. The second paper points out differences betwe turquoise and wavellite. L. J. S.

Lacroix (Alfred). *Les pierres précieuses, semi-précieuses ou d'orn mentation.* Les ressources minérales de la France d'outre-m Paris, 1935, vol. 3, pp. 267–324.

A general review is given of the occurrence of precious stones the French colonies. Diamond has been found near Bria in Uban

° N., 22° E.; M.A. **5**–278, **6**–7] and on the Kadei river in French ongo [4° N., 16° E.] in French Equatorial Africa; in French Guinea West Africa; there is an unconfirmed record from French Guiana South America; and an alleged find in Madagascar has been iscredited [M.A. **5**–57]. Sapphire with zircon and black spinel ccurs at Pailin in Cambodia (Cambodge); ruby at Bo Keou in ambodia; and sapphire in Loas, French Indo-China. By far the ost important occurrences are in Madagascar, which has yielded wide variety of gemstones [M.A. **1**–379; **2**–108, 146]. Statistics e given of output and of prices of rough and cut material.

L. J. S.

IODLEMISS (C. S.). *Precious and semi-precious gemstones of Jammu and Kashmir.* Mineral Survey Reports, Jammu & Kashmir Government, Jammu, 1931, [no. 9], v + 58 + v pp., 7 pls.

The sapphire mines are near the village of Soomjam (= Sumsam) the Padar district at a height of 14,950 feet (38° 27′ N., 76° 23′ E.). e old mine discovered in 1881 became exhausted, but others were nd close by in 1927. Sapphire with grey and some pink corundum found in pockets of kaolin derived from pegmatite. The pegma- c veins penetrate lenses of actinolite-tremolite-rock in crystalline estone. Red and green tourmaline and beryl have also been nd in the same area. Beryl (aquamarine) is also found at Daso Baltistan [M.A. **1**–130]. Other stones described are quartz (rock-ystal), felspar, and serpentine. L. J. S.

ERSONS (A. L.). *The utilization of the semi-precious and ornamental stones of Canada.* Univ. Toronto Studies, Geol. Ser., 1934, no. 36, pp. 13–21, 1 pl.

The collection of the Royal Ontario Museum of Mineralogy at oronto has been considerably augmented as a result of collecting peditions by the staff. While no gemstones of special value have en found, trials have been made in the cutting of semi-precious ones, and these are sold as souvenirs to visitors at the museum. ne most popular are beads and cabochons of amazonite, peristerite, dalite, rose-quartz, garnet, and agate. These are illustrated on very effective coloured plate. Rose-quartz of good quality comes om Brise Lake, Manitoba. Other stones mentioned are amethyst, esolite, mordenite, cancrinite, cordierite, aquamarine, amber, cor-dum, zircon, and scapolite. L. J. S.

Walker (T. L.). *Chemawinite or Canadian amber.* Univ. Toront Studies, Geol. Ser., 1934, no. 36, pp. 5–10, 2 pls.

Small fragments (mostly less than $\frac{1}{8}$ inch, the largest $1\frac{1}{4}$ inch) yellow to brown resin are found near Chemahawin on the shore Cedar Lake, Manitoba. They are mixed with bits of dark woo and are probably derived from coaly beds of Cretaceous age. Th material takes a good polish, but is brittle. Some pieces enclo small insects and some show stalactitic growths. Sp. gr. 1·035–1·05 n_y 1·535–1·537. Analysis by L. J. Rogers gave C 81·40, H 10·7 O 7·23, N 0·32, ash 0·65. L. J. S.

Meteorites and Tektites.

Khan (Mohd. A. R.). *Records of fatalities from falling meteorite* Nature, London, 1935, vol. 136, p. 607.

Heron (A. M.). —— Ibid., 1935, vol. 136, p. 1030.

No authentic cases of persons being killed by the fall of meteorit are on record. L. J. S.

Roy (Sharat Kumar). *The question of living bacteria in meteorite* Geol. Ser. Field Museum Nat. Hist. Chicago, 1935, vol. 6, no. 1 pp. 179–198, 3 figs.

The experiments of C. B. Lipman [M.A. **5**–296] were careful repeated using only small stones with unbroken crusts. In three the twelve tubes of culture media inoculated with meteorite powd bacterial growths were obtained; but growths were also sometim obtained on the control plates. They are best explained by co tamination during the crushing of the material and transferring it the culture medium. [Cf. M.A. **5**–402.] L. J. S.

Gordon (Samuel G.). *Meteorites in the collections of the Academy Natural Sciences of Philadelphia.* Proc. Acad. Nat. Sci. Phil delphia, 1934, vol. 85 (for 1933), pp. 223–231. [Preprin dated 1933.]

This collection, dating from 1812, contains representatives of falls (38 irons, 7 stony-irons, and 40 stones), including the ma portions of Cleveland (Tennessee, 1860), Deal (New Jersey, 182 Kilbourn (Wisconsin, 1911), Oktibbeha County (Mississippi, 185 and Wooster (Ohio, 1858). L. J. S.

ODDACK (Ida) & NODDACK (Walter). *Die geochemischen Verteilungskoeffizienten der Elemente.* Svensk Kemisk Tidskrift, 1934, vol. 46, pp. 173–201, 2 figs.

A lecture before the Chemical Society in Stockholm on the lines of earlier paper [M.A. **5**–6], but with some modifications in the tabuted data on the relative abundance of chemical elements in the rth's crust and in meteorites. L. J. S.

OLDSCHMIDT (V. M.). *Grundlagen der quantitativen Geochemie. II (Seltene Elemente in Meteoriten).* Fortschr. Min. Krist. Petr., 1935, vol. 19, pp. 183–216.

A detailed review with discussion is given of papers dealing with e chemical elements present as minor constituents in meteorites, rting from the papers of W. N. Hartley and H. Ramage (1898) d G. P. Merrill [M.A. **1**–97, 99]. The constituents of the metallic, phide, and silicate portions are distinguished and correlated with author's conception of siderophil, chalcophil, and lithophil ments [M.A. **2**–159]. Cases of disagreement in the distribution these types of elements in terrestrial rocks and in meteorites explained by the formation of the latter under a feeble gravity ce and in the absence of water. [M.A. **1**–97, 405; **2**–34, 35; **3**–8, 395; **4**–425, 427, 433, 515; **5**–6, 7, 8, 73, 152, 301, 402.] L. J. S.

ASLAVSKY (I. I.)] SASLAWSKY (ZASLAWSKY) (J. J.). *Die Zusammensetzung und die Kontraktionsgröße des Erdballs II.* Min. Petr. Mitt. (Tschermak), 1935, vol. 46, pp. 331–341.

From the density of the earth (5·52) and of meteorites it is calcued that the whole earth is composed of silicates 27·7 %, metal ·8 %, and troilite 5·5 %. Allowing for contraction [M.A. **2**–503], e chemical composition is calculated [M.A. **5**–150]. L. J. S.

TIM [PAES LEME] (Alberto). *Analyse espectral quantitativa do germanio nos holosidentos* [sic] *Brasileiros—Bendego e Santa Luzia de Goyaz.* Annaes Acad. Brasileira Sci., 1935, vol. 7, pp. 177–179, 1 fig.

Spectroscopic determinations gave Ge 0·003 % in the Santa Luzia teoric iron and 0·004 in that of Bendego. [Cf. M.A. **5**–152.] L. J. S.

Breckpot (R.) & Lecompte (M.). *L'aérolithe du Hainaut. Étud spectrographique.* Mém. Mus. Roy. Hist. Nat. Belgique, 193 no. 69, 31 pp., 2 pls. [Cf. M.A. **6**–101.]

Spark spectra were taken of the light and dark portions of tl meteorite, of the isolated silicate, troilite, and metal, and of chemic separations and precipitates. The metal shows Fe, Ni, Co (0·7 % Ge (0·02), Cu (0·02), and the silicate portion Si, Mg, Fe, Ca, Na, C Mn, Ti, Cu, Al, V, Sn. Other elements found are Pb, As, Zn, Li, C, Pt, Pd, Ru, Au. These results suggest some errors in the origin analysis [M.A. **6**–101], and new partial analyses give: metal 16·62 troilite 7·02 %, Fe/Ni 9·75, MgO/FeO 4·4. Dark vitrified patches the stone owe their dark colour to finely disseminated metal a troilite. L. J. S.

Coulson (A. L.). *The Perpeti meteorite.* Advance Proc. & Notic Asiatic Soc. Bengal, 1935, vol. 2, pp. 65–68.

—— *Additional stones from the Perpeti meteoric shower.* Ibid., pp. 7 79.

At 11 p.m. on May 14, 1935, a shower of stones fell near Perpe (23° 19′ 30″ N., 91° 0′ 0″ E.) and other villages in the Tippe district, Bengal. Fourteen stones with a total weight of 23,474 gra (the largest 6,690 grams) were recovered. They fell within a rec angular area 5 × 3 miles, the supposed direction of flight (SW. to NE of the meteor being in the direction of the shorter side. The meteori is a friable white chondrite with few chondrules; sp. gr. 3·554. L. J. S.

Coulson (A. L.). *The Patwar meteorite.* Advance Proc. & Notic Asiatic Soc. Bengal, 1935, vol. 2, pp. 94–100.

At 2.20 p.m. on July 29, 1935, a shower of siderolites fell ne Patwar (23° 9′ N., 91° 11′ E., only 17 miles SE. of Perpeti, where shower of stones fell on May 14, 1935) and other villages in t Tippera district, Bengal. Five masses with a total weight of 37,3 grams (the largest 23 kg.) were recovered. They fell, the small pieces first, over an area of $4\frac{1}{4}$ square miles, the longer axis bei here in the direction of the flight ESE.–WSW. The largest pie penetrated soft ground to a depth of 34 inches, and the next large to 24 inches. The meteorite shows large crystals of olivine a granular aggregates of olivine and bytownite set in nickel-iron, wit schreibersite, troilite, oldhamite, lawrencite, and hydrocarbons; s gr. 4·21. L. J. S.

AVECKIS (M.). *Žemaitkiemio meteoritas, kritęs 1933 m. vasario mėn. 2 d.* [Žemaitkiemis meteorite, fallen 1933 year February month 2 day.]—*Der Meteorit von Žemaitkiemis.* Lietuvos Universiteto Matematikos-Gamtos Fakulteto Darbai (Mém. Fac. Sci. Univ. Lithuanie, Sect. Géol.), Kaunas [= Kovno], 1935, vol. 9, pp. 307–341 (Lithuanian with German summary), 9 pls.

At 8.33 p.m. (M.E.T.) on February 2, 1933, a shower of meteoric ones fell between the villages of Žemaitkiemis and Klepšiai, 25° E., 5° 18′ N., in Lithuania [40 km. south of the place of fall of the dvarninkai (Androniškis) meteorite on February 9, 1929; M.A. **4**–19]. A bright light was seen and noises heard in the cloudy night, nd one stone was seen to fall in a garden. A meteor was observed om the Königsberg Observatory in East Prussia. Twenty stones, ie largest 7258 and the smallest 65 grams, with a total weight of 2,194 grams, were collected on the frozen and snow-covered ground, thin an area of $2\frac{1}{2} \times 2\frac{1}{4}$ km., the longer axis being the direction of ght of the meteorite from SSE. to NNW. The stones have a dull rust and consist of grey brecciated olivine and enstatite, with a few nall chondrules, and specks, patches, and veins of metal and troilite. he magnetic portion amounts to 16·49 %, and the bulk analysis ve SiO_2 40·30, TiO_2 0·05, Al_2O_3 3·08, Fe_2O_3 0·20, FeO 11·86, MnO 22, MgO 22·33, CaO 2·30, Na_2O 2·06, K_2O 0·26, P_2O_5 0·30, Fe 11·42, i 0·80, FeS 5·22 = 100·40; sp. gr. 3·60. L. J. S.

NINGER (H. H.). *The Lafayette meteorite.* Popular Astronomy, Northfield, Minnesota, 1935, vol. 43, pp. 404–408, 3 figs.

A dome-shaped stone of about 600 grams is preserved in Purdue niversity at Lafayette [Indiana], and is said to have been seen to ll and was collected by a student a number of years ago. The rounded ont shows radiating stream lines with flow of slaggy material over ne edge. It consists of a drab olive-coloured aggregate mainly of nonoclinic pyroxene with no trace of nickel-iron, and is an achron-rite similar to the Nakhla meteorite. [The name Lafayette has een previously applied to a nickel-rich ataxite from Colorado.]

L. J. S.

OUNTAIN (Edgar D.). *The Bowden meteorite stone.* Rec. Albany Museum, Grahamstown, 1935, vol. 4, pp. 248–253, 2 pls.

This flat conical oriented stone [M.A. **6**–103] has been broken and small piece is missing; the estimated weight of the whole is 603 rams. Sp. gr. 3·39; of the fragment cleaned for analysis d_4^{24} 3·726.

The bulk composition is SiO_2 36·35, TiO_2 0·12, Al_2O_3 2·88, Cr_2O_3 0·32, Fe_2O_3 1·19, FeO 9·01, MnO 0·24, MgO 23·01, CaO 2·21, Na_2O 0·76, K_2O 0·11, H_2O 0·27, Fe 16·10, Ni 1·49, Co 0·06, Fe 3·76 S 2·15 = 100·03, corresponding with felspar 11·02, pyroxene 28·81 olivine 34·41, chromite 0·48, ilmenite 0·15, ferric oxide 1·19, troilite 5·91, nickel-iron 17·65, water 0·27 = 99·89. Fe : Ni = 10·81 : 1 MgO : FeO = 4·62 : 1; composition of the olivine near $4Mg_2SiO_4.Fe_2SiO_4$. The stone is a grey crystalline bronzite-olivine chondrite of the Cronstad type. L. J. S.

Kulik (L.). *On the history of the bolide of 1908 June 30.* Popular Astronomy, Northfield, Minnesota, 1935, vol. 43, pp. 499–504.

—— *On the fall of the Podkamennaya Tunguska meteorite in 1908* Ibid., 1935, vol. 43, pp. 596–599, 1 fig. (map).

Translation of papers published in 1927 [M.A. **5**–302]. L. J. S.

Spencer (L. J.). *Meteorite craters as topographical features on the earth's surface.* Ann. Rep. Smithsonian Inst. Washington for 1933, 1935, pp. 307–325, 5 pls., 3 text-figs.

Reprint of an earlier paper [M.A. **5**–301].

Fenner (C.). *The forms and distribution of australites.* (Abstract.) Rep. Austr. Assoc. Adv. Sci., 1935, vol. 22, p. 143. [Cf. M.A. **6**–18.]

The conclusion arrived at is that australites fell across southern Australia at a geologically recent, but historically remote, time. The suggestion that they are still falling does not accord with the evidence. L. J. S.

Fenner (Charles). *Australites, part II. Numbers, forms, distribution and origin.* Trans. Roy. Soc. South Australia, 1935, vol. 59 pp. 125–140, 3 figs. [Cf. M.A. **6**–18.]

A further distinction is made between the button forms with flange and the lens forms with rims. 'Cores' are derived from lenses by loss of the rim. The forms are explained by the ablation of fused material from a spinning globular mass of glass travelling through the earth's atmosphere. A census is given of about 12,000 specimens (some as fragments) in public and private collections, and it is estimated that from one to ten million remain to be collected. A map shows their distribution in the southern half of Australia and in Tasmania. Australites have a uniformity in composition and form which differ from those of other tektites, and they must have

l originated and fallen at the same time. The various views as to eir origin are reiterated. L. J. S.

ATSON (Fletcher, *Jr.*). *Origin of tektites.* Nature, London, 1935, vol. 136, pp. 105–106.

The fact that meteorites show only a thin fusion crust without ternal heating (even in the better conducting irons there is only a ry narrow heating zone) suggests that tektites could not have been mpletely fused in the earth's atmosphere. The meteoritic theory not satisfactory. L. J. S.

EWINSON-LESSING (Fr.). *De la composition chimique des tectites.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1935, n. ser., vol. 3, pp. 181–185.

Published analyses of tektites differ from those of all terrestrial eous rocks in showing a higher acidity coefficient [M.A. **3**–193] d in the R_2O : RO ratio. L. J. S.

ICKÝ (V.). *Über den Ursprung der Tektitoberfläche.* Mit einer Analyse von J. KOKTA. Zentr. Min., Abt. A, 1935, pp. 270–277, 3 figs. [Cf. M.A. **6**–107.]

CROIX (A.). *Les tectites sans formes figurées de l'Indochine.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 2129–2132.

A few km. south of Muong Nong, prov. Savannakhet, Lower Laos, deposit of tektites has been found. Under 1·05 m. of recent uvium in the upper 10 cm. of ancient lateritic clay within spaces 1 and 9 square metres, 362 and over 2000 fragments were found, ighing respectively 9·7 and 20·6 kg. (largest 3·2 kg.). In all, over area of 100 square metres, 67·5 kg. have been found. All are apeless, rough surfaced, and angular, but of the usual composition. e whole occurrence points to their having resulted from one large l shattered on contact with the earth. A tektite has also been found Tûol Prah Théat near Kompong, Cambodia, in close association th a Buddhist relic of the seventh century, showing it to have len before that date. C. A. S.

CROIX (Alfred). *Les tectites de l'Indochine et de ses abords et celles de la Côte d'Ivoire.* Arch. Mus. Hist. Nat. Paris, 1935, ser. 6, vol. 12, pp. 151–170, 4 pls., 1 text-fig.

Supplementary to the previous monograph [M.A. **5**–303] with later ormation [M.A. **6**–17, 106] and giving a full list of localities and ollection of twenty-six chemical analyses. L. J. S.

Patte (Étienne). *Les tectites d'Haïnan. Géologie et folklore.* Compt Rend. Somm. Soc. Géol. France, 1934, pp. 159–161, 1 fig. [C M.A. **5**–303.]

Tektites are found at Tin Gan on the island of Hai-nan, sout China. The fact that in Indo-China tektites are known to the native as 'devil's dung' ('crottes du diable') does not imply that they hav actually been seen to fall from the sky, since this name is also applie to stone implements. L. J. S.

Rock-forming Minerals and Petrology.

Chudoba (K.) & David (F.). *Der Einfluß der Kalifeldspatkomponen auf die Optik der Plagioklase. I. Die Mallard'sche Formel un ihre Umformung auf drei Komponenten.* Neues Jahrb. Min Abt. A., 1933, Beil.-Bd. 67, pp. 196–216, 11 figs.

Chudoba (Karl F.). *Der Einfluß der Kalikomponente auf d Auslöschungsschiefe der Flächen P* (001) *und M* (010) *der Plagi klase.* Fortschr. Min. Krist. Petr., 1933, vol. 18, pp. 13–1 1 fig.

Mallard's formula (1881) for calculating the optical data for t plagioclases from those of the end-members is extended to thr components—albite, anorthite, and orthoclase. In the second pap curves show the influence of the presence of the orthoclase molecu on the extinction-angles of the plagioclases. L. J. S.

Chudoba (K.). *Zur chemischen Zusammensetzung pegmatitisch u magmatisch gebildeter Alkalifeldspäte.* Centr. Min., Abt. A, 193 pp. 260–273, 3 figs.

The statement [M.A. **5**–217] that the $Al_2O_3 : SiO_2$ ratio of t felspars of pegmatites is abnormal, as compared with those of ma matic rocks, is disputed. L. J. S.

Tsuboi (Seitarô). *Petrological notes* (1)–(10). Japanese Journ. Ge Geogr., 1935, vol. 12, pp. 110–113, 1 fig.

Orthorhombic pyroxenes from Japanese volcanic rocks gave optic data (2V 54–82°, negative, α 1·698–1·704, β 1·706–1·714, γ 1·71 1·717) which do not fit in with A. N. Winchell's (1933) curv Anorthite as clear crystals in an olivine-eucrite block in tuff fr Wadaki, Idu, gave analysis I corresponding with An 97·9 %; α 1·57 β 1·584, γ 1·588, 2V 78°. Cummingtonite in amphibolite from Hit gave α 1·635, β 1·645, γ 1·660, 2V 80°, $c : \gamma = 20°$, and from Akaza

1·635, β 1·644, γ 1·658, 2V 78°, $c:\gamma = 18°$. Analyses II–VII of otite; II from injection biotite-gneiss, Takanuki district, Iwaki; I from a contaminated garnet-bearing gneissose biotite-granodiorite, ugi, Takanuki district; IV from hornblende-bearing biotite-grano-orite, Senmaya, Rikutyû; V from gneissose biotite-granite, Usugi; I from biotite-granodiorite, Takatô, Sinano; VII from biotitic band gneissose granite near Yokodake, Enasan district, Mino. Brown rnblende from amphibolite from Yokodake gave VIII; α 1·653, ·676, 2V 84°, $c:\gamma = 15°$; pleochroism α pale yellow, β and γ pia-brown. Analyses by S. Tanaka.

	SiO_2.	TiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.
I. ...	43·54	trace	35·66	0·58	nil	trace	0·06	19·52
II. ...	34·13	2·62	19·73	2·07	18·97	0·33	7·76	nil
II. ...	34·46	2·52	18·50	1·00	20·09	0·51	8·03	nil
V. ...	36·34	3·29	13·88	4·49	15·00	0·52	11·80	0·28
V. ...	35·87	2·77	16·85	3·37	20·15	0·43	7·20	0·95
I. ...	35·06	3·65	15·58	1·84	20·31	0·32	8·75	0·62
II. ...	36·60	3·30	14·98	1·00	19·23	0·13	11·15	0·18
II. ...	42·44	3·09	12·50	2·07	12·38	0·30	11·43	10·90

		Na_2O.	K_2O.	H_2O+.	H_2O-.	P_2O_5.	Total.	γ_D.
I.	...	0·26	trace	0·20	0·10	trace	99·93	1·588
II.	...	0·21	9·15	4·30	0·18	nil	99·46	1·656
I.	...	0·25	9·09	4·25	0·74	nil	99·44	1·655
V.	...	0·57	8·80	3·60	0·70	0·07	99·34	1·657
V.	...	0·40	8·43	3·58	0·18	0·35	99·86	1·665
I.	...	0·41	8·37	3·97	0·53	trace	99·41	1·658
I.	...	0·37	9·06	3·20	0·20	0·13	99·53	1·650
I.	...	2·21	0·14	1·94	0·15	0·23	99·78	1·676

L. J. S.

VICE (Harold). *Note on the occurrence of clinohypersthene and enstatite-augite in the "norite" from Bluff, New Zealand.* Trans. Roy. Soc. New Zealand, 1934, vol. 64, pp. 147–150.

Most of the pyroxene in this rock is clinohypersthene and enstatite-ite, and not hypersthene and augite as previously described. inohypersthene shows fine lamellar twinning on (100); optic axial ne $\perp$ (010), $\gamma:c = 35°$, 2V 30°, negative, n 1·72, birefringence 23; pleochroism α and β pale rose-pink, γ pale apple-green. tatite-augite shows fine lamellar twinning on (100); optic axial ne (010), extinction-angle large, 2V 25°, positive. The crystalliza- of pyroxene is discussed in connexion with the views of Barth of Tsuboi [M.A. **5**–219]. L. J. S.

WAWRYK (Włodzimierz). *O augicie zwyczajnym i tytanowym z polskic cieszynitów.—Sur l'augite commune et titanifère des teschénites e Pologne.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sc Varsovie), 1935, vol. 11, pp. 175–181 (Polish), p. 182 (Frenc résumé).

Common augite from diabase at Boguszowice gave I, and titaniferou augite from monzonitic teschenite at Marklowice gave II.

	SiO_2.	TiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.	Na_2O.	K_2
I.	49·82	1·38	4·24	4·29	3·76	0·07	14·75	20·82	0·76	0·(
II.	44·71	2·92	7·85	4·46	4·23	0·10	11·74	22·37	0·90	0·(

	P_2O_5.	H_2O+.	H_2O-.	Total.	Sp. gr.	α.	β.	γ.	2V.	c:
I.	0·08	0·29	0·11	100·42	3·316	1·699	1·704	1·725	45°	4
II.	0·12	0·26	0·09	100·34	3·401	1·721	1·725	1·746	51	5(

L. J. S.

ERDMANNSDÖRFFER (O. H.). *Der Granatfels von der Hohen Waid b Schriesheim und die darin enthaltene Hornblende.* Verh. Naturhis Med. Ver. Heidelberg, 1935, vol. 18, pp. 105–109.

Hornblende from the garnet-rock has α 1·095, β 1·706, γ 1·70 $c : \gamma = 23–28°$, 2V $33\frac{1}{2}°$, sp. gr. 3·278. Analysis by H. Nieland gav (after deducting diopside and magnetite) SiO_2 44·09, TiO_2 0·3 Al_2O_3 11·95, Fe_2O_3 4·66, FeO 18·83, MnO 1·58, MgO 3·08, CaO 11·0 Na_2O 1·01, K_2O 1·36, F 0·55, H_2O+ 0·55, H_2O- 1·45. L. J. S.

PICHAMUTHU (Charles S.). *On bababudanite, a soda-amphibole fro banded ferruginous quartzites of Mysore, India.* Geol. Ma London, 1936, vol. 73, pp. 39–45.

A new analysis by W. H. Herdsman of bababudanite (W. F. Smeet 1908) from the Bababudan hills, Kadur district, gave SiO_2 49·8 Al_2O_3 1·56, Fe_2O_3 18·62, FeO 10·59, MgO 9·30, CaO 0·45, Na_2 8·80, K_2O trace, H_2O 0·65 = 99·77, corresponding to $4NaFe'''(SiO_3)$ $2FeSiO_3.3MgSiO_3$ or $2Na_2Fe_2Si_4O_{12}.5(Mg,Fe,H_2,Ca)SiO_3$. Sp. g 3·31; prismatic cleavage 126°; optic axial plane and $\gamma \perp (01($ $a : c$ about 3°, $\gamma - \alpha$ 0·018; pleochroism, α dark Prussian blue, yellow, γ deep violet blue. In composition and optical properties th mineral is allied to rhodusite. The shining black acicular crystals bababudanite are confined to narrow zones at the contact of th banded ironstones with intrusive epidiorite dikes, and the miner is thus of secondary origin in the quartzites. The bababudanit magnetite-schist gave an analysis comparable with those of the amph bole-magnetite-rocks occurring with the Lake Superior band

onstones, and like these it probably originated from chemical diments rather than from igneous rocks. L. J. S.

AVORNIN (A.). *Sur la présence de la phlogopite dans les pyroxénites de la région de Betroka.* Bull. Soc. Franç. Min., 1934, vol. 57, pp. 130–139.

The occurrence of phlogopite in the Betroka region of Madagascar of two types where it is associated (1) with granitic rock of the me age as the pyroxenite, (2) with dissogenites formed after the riod of metamorphism. F. A. B.

ARSEN (Esper S.) & MILLER (Franklin S.). *The Rosiwal method and the modal determination of rocks.* Amer. Min., 1935, vol. 20, pp. 260–273.

A discussion of the limits of error in the micrometric measurement thin sections of rocks. In a single section the error is of the order 1 %, but different sections of the same rock may give results ffering by as much as 20 %. L. J. S.

OWEN (Norman L.). *The igneous rocks in the light of high-temperature research.* Scientific Monthly, New York, 1935, vol. 40, pp. 487–503, 7 figs.

A popular address giving some account of igneous rocks and of e special methods for their investigation at the Geophysical boratory of the Carnegie Institution of Washington. Emphasis is ven to the changes in chemical composition of magmas resulting om fractional crystallization. L. J. S.

OLMAN (Carl) & GOLDICH (Samuel S.). *The granite, pegmatite, and replacement veins in the Sheahan quarry, Granitville, Missouri.* Amer. Min., 1935, vol. 20, pp. 229–239, 6 figs.

Quartz and felspar make up 96–97 % of the 'Missouri red granite'. lspars are albite, orthoclase, and microcline, with various types of rthite. Chemical analyses are given of the rock and the perthite. eryl gave SiO_2 65·23, Al_2O_3 17·99, Fe_2O_3 0·96, FeO 0·57, BeO 13·39, gO 0·06, CaO 0·03, Na_2O 0·52, K_2O 0·01, H_2O+ 1·20, H_2O- 03 = 99·99; sp. gr. 2·682, ω 1·578, ϵ 1·571. Muscovite gave SiO_2 ·92, TiO_2 0·36, Al_2O_3 29·07, Fe_2O_3 3·94, FeO 3·58, MnO 0·06, gO 0·79, CaO trace, Li_2O 0·29, Na_2O 0·27, K_2O 10·68, $H_2O(+110°)$ 20, $H_2O(-110°)$ 0·53, F n.d.; β 1·596, 2V about 30°. L. J. S.

Suzuki (Jan) & Nemoto (Tadahiro). *The chemical composition of th granitic rocks of Japan.* Journ. Fac. Sci. Hokkaido Imp. Univ. Ser. 4, 1935, vol. 3, pp. 1–48, 9 figs.

Chemical analyses and corresponding 'Niggli values' for 13 granitic rocks are listed and the average analysis for Japan and fo nine areal averages are calculated and discussed. A map shows th geographical distribution. References to the literature are given.

W. C. S.

Bjørlykke (Harald). *The mineral paragenesis and classification o the granite pegmatites of Iveland, Setesdal, southern Norway* Norsk Geol. Tidsskrift, 1935, vol. 14, pp. 211–311, 2 pls. 17 text-figs.

Dikes and lenses of microcline-quartz-pegmatite near a granit mass are intrusive into amphibolite. They are usually very coars grained, with crystals of felspar up to 200 tons in weight. Fou types are distinguished according to the rare minerals present thalenite-gadolinite type (gadolinite crystals up to 500 kg.); fergu sonite type; euxenite (samarskite) type; and columbite type. Thes pegmatites are of magmatic origin; the minerals are all primary an show no signs of later replacements. Intersecting them are late dikes of cleavelandite-quartz-pegmatite; these are of hydrothermal pneumatolytic origin, and carry tantalite and microlite. Particular are given of 108 dikes and felspar quarries with the minerals foun in each. Forty-one minerals are described; the rarer element present in them were determined by X-ray spectral analysis.

L. J. S.

Jenks (William F.). *Pegmatites at Collins Hill, Portland, Connecticu* Amer. Journ. Sci., 1935, ser. 5, vol. 30, pp. 177–197, 7 figs.

Lenses and dikes of pegmatite intruded into schist near grano diorite are worked for felspar and mica in the Strickland quarry Three phases are distinguished. (1) Magmatic, with quartz, microclin muscovite, and black tourmaline. (2) Transitional, mainly cleave landite, with spodumene, lepidolite, coloured tourmaline, columbit &c. (3) Hydrothermal, with a potash-bearing albite, tourmalin cookeite, sulphides, phosphates of Li and Mn, apatite, &c. Th tourmaline shows ranges ω 1·632, ϵ 1·614 for pink, to ω 1·665, ϵ 1·638 for black. Beryl ranges from ω 1·582, ϵ 1·576, with alkalis 1·5 % for green, to ω 1·592, ϵ 1·584, with alkalis 3·4 %, for pink. Th potash-bearing albite replaces spodumene, microcline, and cleave

ıdite; analysis gave SiO_2 68·98, Al_2O_3 18·76, Fe_2O_3,FeO 0·09, ;O 0·07, CaO 0·08, Na_2O 9·00, K_2O 2·86, H_2O 0·24 = 100·08; ·525, β 1·531, γ 1·535, 2V 83°, positive, extinction on (010) 19°, (001) 4°. L. J. S.

ASS (Jewell J.). *The pegmatite minerals from near Amelia, Virginia.* Amer. Min., 1935, vol. 20, pp. 741–768, 2 figs.

The Rutherford mine in pegmatite, worked for mica in 1873, has ıg been famous as a mineral locality. The Morefield mine, worked felspar, was opened in 1933. At the latter the pegmatite vein ›ws a symmetrical zonal arrangement with a centre of smoky- ırtz bordered by amazon-stone, then albite and muscovite, and a ·ow selvage of biotite and quartz. The minerals recently collected, l now described, giving optical data, &c., include 31 species, of ch bertrandite, biotite, cerussite, pyrolusite, triplite, and zinn- ldite are new records for the locality. Phenakite and topaz, ntioned by W. S. Yeates (1890), are also now described. Topaz ıbundant in the Morefield mine as crystals up to 500 lb. in weight. ·o types of microlite are described—olive coloured (d 5·49–5·74, ·93–1·94) and dark amber coloured (d 5·9–6·0, n 1·98–2·02). Five nplete chemical analyses are given of different types of sericite, ·e of which are alteration products of topaz, and one analysis of nwaldite. Spectroscopic analysis shows the presence of B, Be, Ge, l Sn in several of the minerals. Luminescence tests were also .de. L. J. S.

APMAN (Randolph W.) & WILLIAMS (Charles R.). *Evolution of the White Mountain magma series.* Amer. Min., 1935, vol. 20, pp. 502–530, 2 pls., 1 text-fig.

The rocks of the White Mtn. district in New Hampshire include wide range of types in each of the plutonic, dike, and volcanic ›ups, of which many chemical analyses are quoted. As a contribu- n to the question of their origin by differentiation, analyses are ·en of minerals isolated from different rock types. It is known .t the ferromagnesian minerals of basic rocks are richer in silica l have a higher Mg : Fe ratio than those of acid rocks. Analyses · F. A. Gonyer) I–III of biotite from gabbro, monzodiorite, and nite respectively. IV hedenbergite from syenite. V hornblende m syenite. VI riebeckite from granite. VII olivine (hyalosiderite) m gabbro. VIII ilmenite from gabbro. As an example of ferentiation by fractional crystallization, calculations give the

amounts of various minerals to be deducted in passing by a series o stages from a gabbro to a granite magma; but this would requir vast quantities of the original magma. The aid of assimilation an pure melting of pre-existing rocks is therefore also invoked.

	SiO_2.	TiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.	Na_2O.	K_2
I.	37·74	5·22	16·31	nil	15·52	0·06	14·23	0·04	0·44	8·8
II.	35·88	4·17	14·96	2·33	20·88	0·18	10·04	0·12	0·36	9·3
III.	33·48	2·94	13·64	8·00	23·54	1·02	4·97	0·56	0·53	7·8
IV.	47·58	0·37	1·16	2·60	24·21	0·59	3·34	18·89	0·47	0·3
V.	46·56	1·83	2·48	6·24	27·27	1·08	1·35	6·15	4·17	1·3
VI.	46·98	1·49	1·29	11·93	23·38	0·24	0·13	1·91	8·90	2·7
VII.	34·96	nil	nil	nil	36·77	0·52	27·04	nil	—	—
VIII.	nil	48·90	—	9·80	38·97	0·36	2·03	—	—	—

	H_2O.	F.	Total.	α.	β.	γ.	2V.	Sign.	Extinction c:
I.	1·17	0·45	99·87	1·596	1·656	1·656	5°	−	α 4°
II.	0·80	1·58	99·84	1·599	1·665	1·665	small	−	α 3
III.	2·63	0·95	99·66	1·606	1·671	1·672	small	−	α 3
IV.	0·34	—	99·67	1·730	1·736	1·755	60°	+	γ 45
V.	1·27	—	99·77	1·688	1·699	1·704	35	−	γ 25
VI.	1·10	—	100·09	1·691	1·694	1·699	large	+	α 3–5°
VII.	—	—	100·58	1·721	1·750	1·765	85°	−	—

L. J. S.

Du Rietz (Torsten). *Peridotites, serpentines, and soapstones of northe Sweden, with special reference to some occurrences in northe Jämtland.* Geol. För. Förh. Stockholm, 1935, vol. 57, pp. 13 260, 5 pls., 59 text-figs.

The numerous small lenticular outcrops of peridotites (main dunite with transitions to saxonite) are mostly altered to serpentin but in areas of more intense metamorphism (with amphibolites, & they are altered to soapstone with the following zonal arrangemen partly serpentinized peridotite; serpentinized peridotite with actin lite and talc; soapstone; chlorite-rock with actinolite and anth phyllite; partly chloritized amphibolite [cf. Min. Mag. **23**–51 Several chemical analyses by R. Blix and N. Sahlbom are given rocks, soapstone, and minerals. I, enstatite from Vuoka Ruopso as crystals 10 cm. long in saxonitic dunite; sp. gr. 3·274, α 1·662 β 1·6668, γ 1·6730(Na), $2V_\gamma$ 82° 22′. II, olivine from the same ro after deducting 6 % enstatite; α 1·649, γ 1·685, $2V_\gamma$ 87°. III, t molite from St. Ålke; α 1·607, β 1·620, γ 1·632, $2V_\alpha$ 78½°, $c:\gamma$ 17½ IV, tremolite from Nordmarken (for comparison); sp. gr. 2·98 α 1·6036, β 1·6188, γ 1·6319(Na), 2V 85°. V, clinochlore fro

Muruhatten, after deducting a little magnetite; α 1·588, β 1·591, 1·596, 2E about 23°, extinction-angle about 4°. VI, pennine rom Sråttekjaure. VII, antigorite from Muruhatten; α 1·564, 1·570. VIII, talc from Muruhatten; sp. gr. 2·791, α 1·550, 1·596. IX, tourmaline from Muruhatten; sp. gr. 3·250, ω 1·648, 1·6256(Na). X, almandine (73·8 %) from Muruhatten; sp. gr. ·145, n 1·8083 (λ 579), n 1·8311 (λ 436). XI, almandine (64·2 %) rom Junsternäset; sp. gr. 4·027, n 1·7903 (λ 579), n 1·8057 (λ 436). II, breunnerite from Säkok Ruopsok. XIII, breunnerite from ejarklumpen. XIV, ankerite from Lermon. XV, ankerite from aisholm.

	SiO_2.	TiO_2.	Al_2O_3.	Cr_2O_3.	Fe_2O_3.
I.	55·80	nil	4·02	0·20	0·76
II.	41·55	—	0·01	—	—
III.	56·34	0·07	1·40	—	—
IV.	57·45	trace	0·13	—	0·70
V.	30·86	18·52	—	0·02	1·53
VI.	34·06	—	10·96	0·16	4·96
VII.	42·94	—	0·46	0·08	1·56
VIII.	62·61	—	trace	—	—
IX.	36·70	1·38	30·97	0·03	1·73
X.	37·21	0·14	20·97	0·02	0·04
XI.	—	—	22·59	—	0·53

	FeO.	MnO.	MgO.	CaO.	H_2O+.	Total.
I.	4·85	—	34·70	—	0·23	100·56
II.	7·34	—	50·83	0·03	0·24	100·00
III.	2·38	0·17	23·81	13·21	2·72	100·50
IV.	1·25	0·36	24·94	14·35	0·75	100·72
V.	6·14	0·04	30·20	—	12·69	100·00
VI.	5·12	—	30·81	0·91	13·38	100·36
VII.	3·13	0·07	38·92	trace	12·56	100·02
VIII.	2·46	0·01	30·22	—	4·72	100·02
IX.	2·94	nil	8·83	1·63	3·49	100·07
X.	32·65	2·02	2·74	3·67	0·15	99·85
XI.	27·04	—	5·08	5·67	—	—

III, also Na_2O 0·10, H_2O- 0·30, F nil. IV, also Na_2O 0·56, K_2O 0·14, H_2O- 09, F nil. VII, also H_2O- 0·30. IX, also Na_2O 2·49, K_2O 0·21, B_2O_3 9·50, $_2O-$ 0·17, F nil. X, also Na_2O 0·14, K_2O trace, H_2O- 0·10.

	CO_2.	FeO.	MnO.	MgO.	CaO.	H_2O-	Total.	Sp. gr.	ω.	ϵ.
XII.	50·89	4·96	0·22	44·10	nil	—	100·17	—	1·715	1·516
III.	51·15	3·84	0·24	44·11	0·43	0·05	99·82	3·041	1·710	1·512
IV.	46·93	1·94	0·30	20·85	30·05	0·07	100·14	2·883	1·686	1·505
XV.	47·40	1·63	0·19	21·05	29·92	0·03	100·22	2·878	1·689	1·505

L. J. S.

[Aleshkov (A. N.)] Алешков (А. Н.). Дунито-перидотитовые массивы Полярного Урала. [*The dunite-peridotite massifs of the Arctic Ural.*]—Aleshkoff (A. N.). *The dunite-peridotite rock formations of the Polar Ural.* (English Summary.) Мат. Ком. эксп. иссл. Вып. 18, Акад. Наук СССР, Ленинград (Mat. Comm. Exped. Invest. no. 18, Acad. Sci. U.S.S.R.), Leningrad, 1929, 120 pp., 1 map, 61 figs.

Numerous detailed descriptions are given of the microscopical characters of the rocks belonging to the peridotite-gabbro formation of the Sob massif in the Arctic Ural. The descriptive work is done in the light of the author's hypothesis, according to which all the rocks belonging to this formation represent hybrids between the original pyroxenite and gabbro and the injected 'molten olivine', which alone can be called 'magma'. S. I. T.

[Loewinson-Lessing (F. Y.)] Левинсон-Лессинг (Ф. Ю.). Что такое дунит?—Loewinson-Lessing (F.). *Qu'est-ce que la dunite?* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. U.R.S.S.), 1928, pp. 403–406.

The recalculation of dunite analyses shows that (excluding minor constituents) only a certain number of them correspond to the pure olivine, the others having an excess of silica. The last group, with a modal or normative enstatite and relegated to the enstatite-dunites (up to 25 % of enstatite), form the transition to saxonites. The enstatite-dunites, usually found in the upper parts of dunite massifs, are probably differentiates of the ultrabasic magma. The enrichment of the upper part of the magma in water led to the widespread serpentinization (autopneumatolysis) of enstatite-dunites. S. I. T.

[Zavaritzky (A. N.)] Заварицкий (А. Н.). Перидотитовый массив Рай-Из в Полярном Урале.—Zavaritsky (A.). *The Rai-Iz peridotite massif in the Arctic Ural.* Гос. Научн.-Техн. Геол.-Разв. Изд. Москва-Ленинград (Sci.-Techn. Geol.-Prosp. State Publ. Moscow-Leningrad), 1932, 221 pp., 1 map, 12 pls., 51 text-figs. (Russian with English summary, p. 170).

This is a very important contribution to the petrology of the peridotite-gabbro plutonic complex of Rai-Iz in the Arctic Ural. It is well illustrated by numerous figures and photomicrographs, and twenty-three chemical analyses of rocks are included. An extensive English summary with full references to the figures and tables of the

ıssian text makes this work accessible to the English reader. The icroscopical characters of igneous and metamorphic rocks are well scribed and their field relations are traced. The injected masses peridotite, pyroxenite, and banded gabbro are in all probability netically connected. The peridotite (and dunite) appears to be an rly product of consolidation, as it is cut by veins and dikes of roxenite, gabbro-pegmatite, albitite, &c., representing the residual uids of the ultrabasic magma. Banded taxitic structure is preva- nt among the ultrabasic rocks and one of the thick bands is made sagvandite (chem. anal. p. 66), the origin of which, like that of the pentine, is explained by autopneumatolysis during the final stage the crystallization of the magma. S. I. T.

ELIANKIN (D. S.)] Белянкин (Д. С.). Лысая Сопка.—Beliankin (D. S.). *Lysaia Sopka*. Изв. Вс. Геол.-Разв. Объед. (Bull. United Geol.-Prosp. Service U.S.S.R.), 1932, vol. 51, no. 55, pp. 805–815, 1 pl., 1 map (Russ. with Engl. summary, p. 814).

Lysaia Sopka, a small hill near Kyshtym (Ural Mts.), is composed serpentine, injected by gneiss, amphibolites, and plagioclasites. rmiculite (analysis p. 812) and a new variety of foliated serpen- ne—sungulite (analysis p. 810)—are described. S. I. T.

UZNETZOV (E. A.)] Кузнецов (Е. А.). Щелочные породы южной части Кыштымской дачи.—Kuznetzow (E. A.). Alkaline rocks of the southern part of Kyshtym district, Ural. Научно-Техн. Упр. В.С.Н.Х. (Sci. Techn. Dept. Supreme Council of National Economy), no. 371, Труды Инст. Прикл. Мин. Метал. (Trans. Inst. Econ. Min. Metall.), no. 48, Moscow, 1930, 89 pp., 1 map, 9 figs. (Russian with English summary, p. 87).

The district studied (continuation of the Ilmen Mts.) is composed alkali rocks, including nepheline-syenite, alkali-syenite, miaskite, d granite-gneiss with intercalated bands of amphibolite, quartzite, d garnet-gneiss. The miaskite is characterized by the presence primary calcite, which, together with mica, occurs in the form of lieren at the margin of the intrusion. The relation of miaskite granite is discussed, and a suggestion is made that the former y be a product of desilification of the latter. Seventeen analyses rocks are given. Certain rare minerals of the pegmatites and ites are mentioned, such as tourmaline (blue, grey, and rose), mortierite, cordierite, and beryl. S. I. T.

[Kuznetzov (E. A.)] Кузнецов (Е. А.). Петрографическое описани Соймоновской долины. II. Сугурские горы.—Kouznetsow (E. A. *Petrographical description of the valley of Soimonovsky. II. Th Sougour Mountains.* Научно-Техн. Упр. В.С.Н.Х. (Sci. Techr Dept. Supreme Council of National Economy), no. 229, Труд Инст. Прикл. Мин. Метал. (Trans. Inst. Econ. Min. Metall. no. 37, Moscow, 1928, 56 pp., 1 map, 9 figs. (Russian wit English summary, p. 52).

The Sougour Mountains, near Kyshtym (Ural) are compose mainly of serpentines, pyroxenites, gabbros, listwänites, and talc carbonate rocks. These rocks are described, and eight analyses ar given (p. 33). The processes of autopneumatolysis and metamorphisı of the adjoining limestones are discussed. S. I. T.

[Sobolev (N. D.)] Соболев (Н. Д.). Петрографический очерк севе ного участка Абзаковского месторождения хризотил-асбест (Южный Урал).—Sobolev (N. D.). *The petrographical study the northern section of the Abzakovsky deposit of chrisotyle-asbest (Southern Ural).* Пл. Техн.-Экон. Упр. В.С.Н.Х. (Sci.-Researc Dept. Supreme Council of National Economy), no. 423, Труд Инст. Прикл. Мин. (Trans. Inst. Econ. Min.), no. 49, Moscov 1930, 41 pp., 1 map, 16 figs. (Russian with English summar p. 41).

The author gives a description of serpentine (originally lherzolite an injected quartz-porphyry, and the contact-altered rocks. Si analyses of rocks are given. S. I. T.

[Arshinov (V. V.) & Merenkov (B. Y.)] Аршинов (В. В.) и Мере ков (Б. Я.). Красноуральское месторождение хризотил-асбес (Средний Урал). [*Krasnouralsky deposits of chrysotile-asbest (Middle Ural).*]—Arshinov (V.) & Merenkov (B.). *Petrology chrysotile asbestos deposits of the Krasnouralsky asbestos mine the Ural mountains.* Научно-Техн. Упр. В.С.Н.Х. (Sci. Tech Dept. Supreme Council of National Economy), no. 363, Труд Инст. Прикл. Мин. (Trans. Inst. Econ. Min.), no. 45, Moscov 1930, 83 pp., 1 map, 40 figs. (Russian with English summar p. 80).

Besides the description of the asbestos mine the authors give detailed petrographical account of the rocks and thirteen analys are included. They postulate a dioritic primary magma which b differentiation gives rise on the one hand to the ultrabasic rocks, an

the other to the albitites and aplites. The serpentine-rocks are plained as the products of autopneumatolysis of the original xonite. S. I. T.

NDERSON (Charles A.). *Alteration of the lavas surrounding the hot springs in Lassen volcanic national park.* Amer. Min., 1935, vol. 20, pp. 240–252.

Analysis of the fresh core of a dacite block, of the bleached nsition zone, and of the white powdery exterior, show an increase SiO_2 from 63·80 to 92·20 and a decrease in Al_2O_3 from 17·55 to 02. The final alteration product consists of opal with small ounts of kaolin, alunite, and tridymite. The alteration is due to e action of sulphuric acid (0·04 %) present in the spring water. ith less sulphuric acid the final product is mainly kaolin.

L. J. S.

RGA-PONDAL (Isidro). *Quimismo de las manifestaciones magmáticas cenozoicas de la Península Ibérica.* Trab. Museo Cienc. Nat. Madrid, 1935, Ser. Geol., no. 39, 174 pp., 56 figs. Price 10,00 Pesetas.

122 chemical analyses (including several new) of igneous rocks of tiary age in various districts are tabulated and plotted with the iggli values'. The rocks of the Bética orogenic region in the th-east of Spain (including the island of Alborán, Cabo de Gata, d Sierra de las Cabras) belong to the Pacific province. Those tending across the peninsula from Gerona in the north-east to the ra de Monchique and Lisbon belong to the Atlantic province. third group lying between these two regions belong to the mproitic Mediterranean province. L. J. S.

MKEIEFF (S. I.). *Differentiation in basalt lava, Island Magee, Co. Antrim.* Geol. Mag. London, 1934, vol. 71, pp. 501–512, 1 fig.

Analyses and descriptions are given of the upper, middle, and ver zones of one of the flows (12 feet thick) of olivine-basalt at e Gobbins, Island Magee. In the upper vesicular zone zeolites mprise 25–50 % of the rock and consist of about 90 % chabazite aal. I; sp. gr. 2·160, n 1·47), and 10 % thomsonite (II; sp. gr. 285, n 1·51–1·53). The middle zone is compact olivine-basalt ateau magma type of Mull), and the lower zone a basalt with merous phenocrysts of olivine (III; sp. gr. 3·339, α 1·662, β 1·695).

Iddingsite (bordering the olivine) sometimes has an outer zone which is compared to the mineral from Carnmoney Hill, near Belfast first noted by E. Hull in 1876, and named hullite by E. T. Hardman in 1878. A new analysis (IV; sp. gr. 2·071, n 1·464) of this mineral proves it to be chlorophaeite. Another mineral found in a cavity with calcite in agglomerate at Carnmoney Hill proves on analysis (V; n 1·57–1·63) to be chloropal (nontronite). The differentiation in the basalt flow at Island Magee is attributed to sinking of olivine accompanied by rise of volatiles (mainly water).

	SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MgO.	CaO.	Na_2O.	K_2O.	H_2O+.	H_2O-.	Total
I.	43·45	22·37	0·12	—	trace	7·90	4·48	trace	15·82	5·78	99·92
II.	39·90	29·81	0·91	—	trace	9·91	5·98	0·16	9·35	4·25	100·27
III.	40·47	0·19	—	10·54	48·09	0·29	—	—	0·25	—	99·80
IV.	34·30	3·74	19·63	1·52	6·49	1·50	0·93	1·85	7·00	22·85	99·91
V.	42·03	3·93	31·69	0·09	0·53	1·99	0·12	0·09	8·50	11·30	100·27

III, also MnO trace; IV, also MnO 0·09.

W. C. S.

Walker (T. L.). *Magmatic differentiation as shown in the nickel intrusive of Sudbury, Ontario.* Univ. Toronto Studies, Geol. Ser., 1935, no. 38, pp. 23–30, 2 figs.

The average of analyses of the micropegmatite, transition zone and norite show an increase in TiO_2 and P_2O_5 with increasing specific gravity, indicating an increase in ilmenite and apatite downward. But the plots of specific gravity [M.A. **6**–123] show a maximum in the transition zone or at the top of the norite rather than at the base. This is explained by the early consolidation of the basal portion, thus hindering the sinking of heavier minerals during the differentiation of the whole intrusive. L. J. S.

Thomson (Robert). *The 'offset dikes' of the nickel intrusive, Sudbury, Ontario.* Amer. Journ. Sci., 1935, ser. 5, vol. 30, pp. 356–367, 1 fig.

The dark, fine-grained rocks of dikes, up to 120 feet wide, at the Worthington and Creighton mines and near Ethel Lake contain andesine 27–52, amphibole 21–32, biotite and accessories 10–24, quartz 17–25 %, and in chemical composition (SiO_2 57·90–60·12 %) are intermediate between the norite and granophyre of the intrusive. It is suggested that they represent the composition of the parent magma from which the norite and granophyre were derived.

L. J. S.

DMSON (Robert). *Sudburite, a metamorphic rock near Sudbury, Ontario.* Journ. Geol. Chicago, 1935, vol. 43, pp. 427–435, 3 figs.

Sudburite (of A. P. Coleman, 1913), originally described as a variety norite, is shown to be a fine-grained plagioclase-augite-hornfels, med from greenstone by the recrystallization of felspar and the eration of hornblende to pyroxene, by the action of the later kel intrusives. L. J. S.

RLBUT (Cornelius S. *Jr.*). *Dark inclusions in a tonalite of southern California.* Amer. Min., 1935, vol. 20, pp. 609–630, 9 figs.

At the contact of the Bonsall tonalite with the San Marcos Moun- n gabbro there is a transition zone of hybrid rock, and the adjacent alite contains abundant spheroidal, ellipsoidal, and streaky ches, which are regarded to be reaction inclusions derived from slightly older gabbro. The inclusions consist of plagioclase An_{45}, often zoned and sometimes with a core of An_{90} evidently ived from the gabbro), hornblende (with optical data indicating re Mg and less Fe than the hornblende of the tonalite), biotite th less Fe than that of the tonalite), little quartz and orthoclase, traces of augite and hypersthene (remnants from the gabbro). L. J. S.

SKY (Samuel G.). *Igneous assimilation and associated contact metamorphism in the Virginia mining district, New Mexico.* Amer. Min., 1935, vol. 20, pp. 552–561, 5 figs.

A stock of granodiorite is intruded into basalt. At the contact, a distance of 20 feet, the grandiorite is darker in colour, and ludes fragments of basalt; it contains much augite, a more basic gioclase, and more magnetite than the normal rock. The basalt, a distance of 15 feet, shows a development of biotite, orthoclase, d quartz, the pyroxene is changed to amphibole, and the plagioclase less basic. L. J. S.

YNOLDS (Doris L.). *The genetic significance of biotite-pyroxenite and hornblendite.* Min. Petr. Mitt. (Tschermak), 1935, vol. 46, pp. 447–490, 1 fig.

The biotite-pyroxenite of the Newry igneous complex in Co. Down, land, is believed to represent the parent magma from which the ner rocks (monzonite, syenite, diorite, granodiorite) have originated its action on the surrounding sedimentary rocks. Emanations h in alkalis first gave rise to a felspathization of the sediments,

which were then soaked with the highly fluid magma. Simila occurrences of biotite-pyroxenite or hornblendite in other regio are compared. L. J. S.

Ebert (H.). *Hornfelsbildung und Anatexis im Lausitzer Massi* Zeits. Deutsch. Geol. Gesell., 1935, vol. 87, pp. 129–147, 5 pl

The contact-metamorphism around the Lausitz biotite-granodiori is of different types, ranging from hornfeles, through assimilate and hybrid rocks, to a complete recrystallization and granitizatio (anatexis) yielding a two-mica granite. L. J. S.

Sugi (Kenichi). *A preliminary study on the metamorphic rocks southern Abukuma plateau.* Japanese Journ. Geol. Geogr., 193 vol. 12, pp. 115–151, 2 pls., 4 text-figs.

The metamorphosed igneous and sedimentary rocks of this distri in NE. Japan show well-marked grades of metamorphism, rangi from phyllites and green-schists to hornblende-biotite-gneiss, as w as diaphthoritic rocks. Several chemical analyses of the rocks a optical determinations on the constituent minerals are given. L. J. S.

Daly (John W.). *Paragenesis of the mineral assemblage at Crestmo Riverside County, California.* Amer. Min., 1935, vol. 2 pp. 638–659, 1 fig. (map).

A geological map is given of the Crestmore quarries where ma rare contact minerals have been found [M.A. 1–20]. Palaeozoic sandstones, shales, and limestones have been intruded by p Cretaceous plutonic rocks in the order hypersthene-quartz-diori granodiorite, quartz-monzonite-porphyry, granite-porphyry, a pegmatite. Large masses of garnet, idocrase, and quartz-garn contact rocks are developed. Details are given of some of t minerals, and lists are given of those associated with the differe rocks. Some of the contact minerals have undergone later chang producing later generations of contact minerals. L. J. S.

Wiseman (John Dugdale Holt). *The central and south-west Highla epidiorites: a study in progressive metamorphism.* Quart. Jou Geol. Soc. London, 1934, vol. 90, pp. 354–417, 1 pl., 9 text-fi

The regional metamorphism of dolerite sills in the Highlands Scotland is marked by successive zones, each characterized by bioti

lorite, garnet, kyanite, and fibrolite. A comparison is made of minerals in these zones, and their changes are discussed. Anal. I N. Sahlbom) is of hornblende (α 1·637, β 1·652, γ 1·664, $c:\gamma = 20°$) m chlorite-epidote-albite-amphibolite at Loch Gair, Argyll; II hornblende (α 1·673, β 1·686, γ 1·695, $c:\gamma = 19°$) from garnet-otite-epidote-albite-amphibolite at Loch-na-Craige, Argyll; III of rnblende (α 1·663, β 1·677, γ 1·687, $c:\gamma = 19°$) from biotite-idote-albite-amphibolite at the same locality (also in the garnet ne but free from garnet). These analyses are adjusted to the molite formula $H_2Ca_2Mg_5(SiO_3)_8$. IV gives the composition of chlorite (β 1·637) calculated from the analysis of a chlorite-albite-ist. V, garnet from the same rock as II. Hornblende and rite have been produced from pyroxene (or olivine) and plagio-se, and in the lower-grade metamorphism have β 1·632–1·664 and 607–1·637 respectively. In the garnet zone the hornblende has her refractive indices.

SiO_2.	TiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.	Na_2O.	K_2O.	H_2O.
51·60	0·50	2·35	2·60	15·21	0·20	12·91	10·97	0·91	0·53	2·61
47·93	1·25	7·98	2·95	17·79	0·20	7·08	10·45	1·36	0·81	2·27
47·35	0·70	8·47	2·83	17·16	0·25	8·83	10·16	0·65	1·34	2·05
28·2	—	24·9	0·2	26·8	—	10·9	—	—	—	9·0
38·44	—	20·62	7·39	17·09	4·22	2·51	10·08	—	—	—

L. J. S.

URNER (F. J.). *Schists from the Forbes Range and adjacent country, western Otago.* Trans. Roy. Soc. New Zealand, 1934, vol. 64, pp. 161–174, 1 pl., 1 text-fig.

—— & HUTTON (C. O.). *Stilpnomelane and related minerals as constituents of schists in western Otago, New Zealand.*

Stilpnomelane, of common occurrence in these schists and phyllites, micaceous and yellowish-brown with strong pleochroism, ϵ bright golden yellow, ω deep yellowish brown; ϵ 1·592, ω 1·680. A partial analysis gave SiO_2 49·40, Al_2O_3 6·22, Fe_2O_3 19·22, FeO 2·52, Na_2O 2·2, K_2O 0·95. These low-grade metamorphic rocks of the chlorite zone contain albite, quartz, chlorite, epidote, &c., together with 20% stilpnomelane; they have been mostly derived from graywackes, though some are green-schists derived from basic tuffs. Riffithite, found in a single specimen of fine-grained red schist, is pleochroic, ϵ pale yellow, ω deep olive-green; ϵ 1·498, ω 1·595.

L. J. S.

Vendl (Aladár), Takáts (Tibor), & Földvári (Aladár). *A budapes környéki löszről.—Studien über den Löss der Umgebung v Budapest.* Mat. Természettud. Értesítő, Budapest, 1935, vol. 5 pp. 713–787 (Hung.), p. 788 (Germ. title only), 1 pl., 18 tex figs.

Vendl (A.), Takáts (T.), & Földvári (A.). *Studien über den L der Umgebung von Budapest.* Neues Jahrb. Min., Abt. A, 193 pp. 117–182, 1 pl., 8 text-figs.

Detailed mechanical, mineralogical, and chemical analyses a given of several samples of loess from the neighbourhood of Budapes Sp. gr. 2·73–2·77. The grain-size ranges from 0·0005 – > 2·0 mm but for the larger part of the material is 0·02–0·05. Mineral conten are quartz 33–50, carbonates (largely secondary calcite) 12·35–41·3 mica 8–13 %, with the heavy minerals hornblende, garnet, magneti kyanite, zircon, rutile, &c. Chemical analyses show SiO_2 37·80–60·8 Al_2O_3 7·43–12·52, Fe_2O_3 2·53–4·29, MgO 2·80–5·84, CaO 5·10–21·22 &c. Deducting carbonates and water, there is little difference b tween the different samples. The material has been transported wind from the flood plain of the Danube. V. Z.

MacCarthy (Gerald R.). *Eolian sands: a comparison.* Amer. Jou Sci., 1935, ser. 5, vol. 30, pp. 81–95, 7 figs.

Dune sands from the United States, Algeria, and Rajputana we graded according to size of grains, and the roundness of the gra of each fraction determined by measuring their area and circu ference. The results are compared with those obtained with coas sands (ibid., 1931, vol. 22, p. 35) and beach sands (ibid., 19 vol. 25, p. 205). The roundness of both eolian and beach sa decreases with grain-size. Eolian sands are much more round than beach sands, especially with the smaller grains. Eolian sa are transported mainly by rolling on the ground. L. J. S

Economic Minerals and Ore-deposits.

Meen (V. B.). *The temperature of formation of quartz and so associated minerals.* Univ. Toronto Studies, Geol. Ser., 19 no. 38, pp. 61–68, 2 figs. [Cf. M.A. **6**–92.]

Specimens of vein quartz from Canadian mines were examined α- and β-quartz (i.e. quartz formed below or above 575° C.). majority of veins are found to be of the low-temperature type, those with gold and tourmaline may belong to either type. L. J. S

ORDES (Ernst). *Die Beziehungen zwischen den Dissoziationsdampfdrucken von Sulfiden und ihrer Ausscheidungsfolge auf magmatogenen Erzlagerstätten.* Min. Petr. Mitt. (Tschermak), 1935, vol. 46, pp. 256–288, 4 figs.

Dissociation vapour-pressure curves (compiled from the literature) r Zn, Cu, Fe, Ag, Pb, Bi, Sb, As, Hg sulphides are in much the me order as that in which the corresponding sulphide minerals are posited in hydrothermal veins; i.e. the least volatile are deposited rlier. L. J. S.

ADSON (A. S.). *The influence of potential in ore deposition.* Univ. Toronto Studies, Geol. Ser., 1935, no. 38, pp. 51–60, 1 fig.

Polished surfaces of the mixed ores from Cobalt, Ontario, were ated with silver sulphate solution. Niccolite, rammelsbergite, d temiskamite are quickly attacked; löllingite, safflorite, smaltite, loanthite, and skutterudite only slowly; and mispickel, cobaltite, rsdorffite, breithauptite, and silver are not attacked. Minerals of e first group form an electro-negative pole, and metallic silver is posited on other minerals in contact with them. With $Ag_2SO_4 + HF$ ithauptite and niccolite are strongly attacked, but niccolite is otected when in contact with breithauptite. Polished sections of ores often show a replacement of niccolite and breithauptite by tive silver. L. J. S.

RIEGER (Philip). *Primary native silver ores at Batopilas, Mexico, and Bullard's Peak, New Mexico.* Amer. Min., 1935, vol. 20, pp. 715–723, 8 figs.

Native silver is intimately associated with safflorite and rammelsrgite at Batopilas and with nickel-skutterudite at Bullard's Peak. is association of primary (hypogene) native silver with nickel-balt arsenides is similar to the occurrence at Cobalt in Ontario and me other localities. L. J. S.

ÑA DE RUBIES (S.) & DOETSCH (J.). *Pyroelektrische Konzentration zur Spektralbestimmung von Y, La und anderen seltenen Erden in Bleimineralien.* Zeits. Anorg. Chem., 1934, vol. 220, pp. 199–200.

— —— *Bogenspektralanalytisch nachweisbare Elemente in Bleimineralien.* Zeits. Anorg. Chem., 1935, vol. 222, pp. 107–112.

A large number of specimens of lead ores were examined spectroaphically, and the elements detected are listed. M. H. H.

Brown (James Chapman). *Lagerstättliche und erzmikroskopisc Untersuchung der Zinnerzgänge der East Pool-Mine bei Redruth Cornwall.* Neues Jahrb. Min., Abt. A, 1934, Beil.-Bd. 68, p 298–336, 9 pls. Reprints as Inaug.-Diss. Freiburg i. Br., 193

A review of the geology of the tin veins of Cornwall is followed a detailed account of the Moreing and Rogers veins which cut granit elvan, and killas in East Pool mine. Specimens of rocks and or taken from different parts of the veins were examined in thin a polished sections. Cassiterite belongs to both pneumatolytic a hydrothermal phases in the formation of the veins. Associat minerals are wolframite, stannite, chalcopyrite, cubanite, &c. Spectr scopic analysis of the various minerals shows the presence of Cr, Ni, Ga, Ge, rare-earths, Nb, Ta, &c. L. J. S.

Moritz (H.). *Die sulfidischen Erze der Tsumeb-Mine vom Ausgehend bis zur XVI. Sohle (–460 m).* Neues Jahrb. Min., Abt. A, 19 Beil.-Bd. 67, pp. 118–154, 6 pls., 12 text-figs. Reprints Inaug.-Diss. Freiburg i. Br., 1933.

Metallographic and spectrographic examination of a series of specimens from Tsumeb, South-West Africa. Analysis by Klemm carefully selected germanite free from tennantite gave S 31·27, 1·37, Ge 10·19, Ga 1·85, Fe 7·80, Cu 42·12, Zn 3·93, Pb 0·96 = 99·4 formula $Cu_8(Zn,Fe,Ga)_2.(Ge,As)_2S_{11-12}$ or $R_{10}(Ge,As)_2S_{11-12}$. Luzon was found. 'Green enargite' [M.A. **4**–229] is identified with tenna ite. Four kinds of chalcosine are distinguished. L. J. S

Schwellnus (C. M.). *The nickel-copper occurrence in the Bushv igneous complex west of the Pilandsbergen.* Bull. Dept. Mi South Africa, Geol. Ser., 1935, no. 5, 36 pp., 9 figs. Price 6

This mining area was reported upon by the late P. A. Wagne 1924 [M.A. **3**–44] and by R. D. Hoffman in 1931 [Econ. Geol. 2 202]. The writer of the bulletin adds little to the work of Wag and Hoffman, and although he professes to disagree with Wagn view of the genesis of the ore-bodies, yet it is evident in his summi up that the difference is one of degree rather than kind. Schwell writes of an 'ore-magma', Wagner wrote of 'molten copper-ni matte', but both mean the same thing. The plans and sections of ore-bodies form the most valuable part of the bulletin, which suf from the lack of careful editing and proof-reading. S. J. S

EPOLI (P.). *Étude microscopique de quelques minerais des filons argentifères du Sarrabus (Sardaigne)*. Bull. Soc. Franç Min., 1933, vol. 56, pp. 277–302, 6 pls.

A study of polished sections of ores from the silver-bearing deposits Sarrabus, Sardinia, reveals the presence of pyrrhotine, berthierite, nmelsbergite, and safflorite hitherto unrecorded for that locality. e copper and iron minerals have been formed in the order mispickel, rrhotine, chalcopyrite, berthierite. The occurrence of native silver primary origin relates the Sarrabus deposits to those of Freiberg, xony, and Andreasberg, Harz. F. A. B.

EPOLI (P.). *Étude microscopique de quelques minerais du filon cobalto-nickélifère de Riu Planu is Castangias (Gonnosfanadiga, Sardaigne)*. Bull. Soc. Franç. Min., 1934, vol. 57, pp. 270–282, 1 pl.

obalt-nickel ores from Riu Planu is Cantangias, Gonnosfanadiga, dinia, have been studied by the examination of polished sections polarized light and by chemical tests. The constituent minerals heir order of deposition are smaltite-chloanthite, niccolite, safflor- and linnaeite (the first recorded occurrence of linnaeite in Italy). F. A. B.

ER (Paul F.). *The geology of the tungsten deposits near Mill City, Nevada*. Univ. Nevada Bull., 1934, vol. 28, no. 2, 46 pp., 29 figs.

Tungsten camp near Mill City is now the chief producer of tungsten he United States. Small white grains of scheelite are disseminated h tremolite, wollastonite, garnet, epidote, &c., in thin bands of tamorphic limestone in hornfels near a granodiorite contact. The ish-white fluorescence of the scheelite is made use of in the mination of the ore and the mill products. L. J. S.

OMSON (Ellis). *Mineralization of the Little Long Lac and Sturgeon River areas*. Univ. Toronto Studies, Geol. Ser., 1935, no. 38, pp. 37–45, 2 figs.

Ore specimens from these two new mining districts in Ontario re examined in polished and thin sections. Together with small ounts of native gold, they show chalcopyrite, pyrite, galena, zinc- nde, &c., and from Little Long Lac also berthierite. L. J. S.

Thomson (Ellis). *Telluride ores in Ontario and Quebec.* Univ. Toront Studies, Geol. Ser., 1935, no. 38, pp. 47–49, 3 figs. [Cf. M.A **2**–39, 238; **4**–142; **6**–94.]

Additional occurrences of tellurides associated with native gol are recorded from Gold Shore mine, Red Lake, Ontario (tetradymite Bigstone Bay, Lake of the Woods, Ontario (tetradymite, calaverit petzite, hessite); McWatters mine, Rouyn township, Quebec (tetra dymite, hessite). L. J. S.

Willbourn (Eric Stewart) & Ingham (Frank Tinley). *The geolog of the scheelite mine, Kramat Pulai Tin Limited, Kinta, Federate Malay States.* Quart. Journ. Geol. Soc. London, 1933, vol. 8 pp. 449–479, 7 pls., 8 text-figs.

This mine has yielded some 2000 tons of pure scheelite. The o forms large pockets in white marble near the granite contact, and consists of a coarse-grained intergrowth of colourless fluorite an white scheelite, with very small amounts of quartz, calcite, wolla tonite, and bustamite. The occurrence is different to that of oth scheelite deposits, and was evidently due to the action of solutio rich in tungsten fluoride on the limestone at a late stage of t granite intrusion and at a comparatively low temperature. Analys are given of andradite and idocrase and of pyroxene-schist and biotit schist from the contact zone. L. J. S.

Hsieh (C. Y.) with Sun (C. C.), Cheng (Y. C.), & Chern (K.). *Geolo of the iron deposits in the lower Yangtze region.* Mem. Ge Surv. China, Ser. A, 1935, no. 13, vi + 191 pp. (English), ii + pp. (Chinese), 42 pls., 45 text-figs.

Fuller details are given of the deposits of iron ore in southe Anhui [M.A. **5**–417], and the similar deposits in the same region northern Kiangsi and near Nanking are also described. Hedenbergi (previously referred to babingtonite [M.A. **5**–417]) is abundant fibrous radiating masses; it shows a remarkable pleochroism, α de green, β light green, γ brownish-yellow; α 1·7273, β 1·7309, 2V 7 $c : \gamma = 30°$; analysis I by S. C. Liang. Nontronite (previously r ferred to jenkinsite) is abundant as an alteration product of actin lite; α 1·5763, β 1·5937, γ 1·5987; analysis II (evidently large actinolite):

	SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MgO.	CaO.	H_2O+.	H_2O-.	Total.	Sp.
I.	45·27	6·90	7·41	21·07	0·51	18·45	—	0·64	100·25	3·4
II.	51·93	2·75	12·04	7·40	23·63	10·62	2·14	1·19	100·98	2·4

Special chapters are devoted to the apatite crystals and alunite posits associated with the iron ores. A genetic classification of iron ore deposits of China includes five classes—magmatic, limentary, residual, detrital, and metamorphic—represented by enteen different types. L. J. S.

OCH (Olaf Anton). *Feltspat IV. Forekomster i Akershus og Østfold øst for Glomma.* Norges Geol. Undersøk., 1934, no. 141, 119 pp., 23 figs. (Norwegian with English summary).

Particulars are given of the occurrence of felspar, quartz, and mica 180 quarries in pegmatite dikes in the counties of Akershus and tfold, east of the river Glomma in SE. Norway. Information on tput and history is also given. Other minerals (cleveite, columbite, ryl, tourmaline, &c.) are of rare occurrence, except in the dikes ar the Idefjord granite. L. J. S.

ASSERSTEIN (B.). *Gypsum in the Union of South Africa.* Bull. Dept. Mines, South Africa, Geol. Ser., 1935, no. 3, 35 pp., 2 figs. Price 1*s*.

Gypsum has been worked in South Africa since 1913, the output 1934 being 25,680 tons. The bulk of this is not of the highest de of purity, but it is suitable for all purposes for which a dead- ite colour is not essential. The properties and uses of gypsum discussed, and brief descriptions are given of most of the known currences in South Africa. The origin of the deposits is discussed the final chapter; in some instances the mineral has been formed ectly by evaporation of sea-water, but in others it is believed to ve originated from the oxidation of pyrite in the vicinity of lime- ne. S. J. S.

UPFERBURGER (W.). *The travertine deposits near Port St. Johns.* Bull. Dept. Mines, South Africa, Geol. Ser., 1935, no. 4, 15 pp., 3 figs. Price 6*d*.

Two deposits of travertine on the banks of the Umzimvubu river ve been worked for lime, and attention has recently been drawn to em as possible sources of marble for building purposes. The bulk the material is banded travertine, with bodies of beautiful onyx- rble showing a wide variety of colour and design. The deposits re undoubtedly formed by springs, and chemical analyses are given the waters of several springs in the vicinity. S. J. S.

Tućan (Fran). *Prilog mineralnome i kemijskome poznavanju lički boksita.* Rad Jugoslav. Akad. Znanosti i Umjetnosti, Zagreb 1934, vol. 249, pp. 46–79, 5 pls. (Croatian).

—— *Beitrag zur mineralischen und chemischen Kenntnis der Bauxite aus Lika.* Bull. Internat. Acad. Yugoslave Sci. Arts, Cl. Sc. Mat. Nat., 1934, vol. 28, pp. 5–18 (German summary).

Microscopical examination by the author in 1911–1913 of bauxite and 'terra rossa' from the karst districts did not detect the presence of boehmite (bemit in Croatian!) and kaolinite, since detected in French bauxite. X-ray examination now shows these to be present in some of the bauxites of the Lika division of Croatia, and this confirmed by microscopical examination; but goethite and halloysite could not be detected. The boehmite has the form of minute grains and spindles, and is optically negative. The main constituent sporogelite (n 1·623–1·624) or diaspore, with some haematogelite quartzine, pyrophyllite, &c. Seven analyses show the extreme values SiO_2 10·51–44·00, TiO_2 1·09–2·71, Al_2O_3 43·73–69·93, Fe_2O_3 trace 13·59, V_2O_5 0·02–0·04, &c., sp. gr. 2·868–3·236. These compact bauxites of Lika were derived from limestone and dolomite Triassic time; while the more friable bauxites of Dalmatia and Herzegovina were formed in Tertiary time, and consist mainly gibbsite. L. J. S.

[Fersman (A. E.)] Ферсман (А. Е.). Апатито-нефелиновая проблема Хибинских тундр. [*The apatite nepheline problem of the Khibins tundra.*] Материалы по химизации народного хозяйства СС [Materials for chemicalizing national economy U.S.S.R.], Leningrad, 1929, no. 5, 95 pp., 14 pls., 5 text-figs. Price 2 rub.

Granigg (B.). *Die Apatitlagerstätten in den Tundren von Chibi (Halbinsel Kola).* Zeits. Prakt. Geol., 1933, vol. 41, pp. 1–25–31, 58 figs.

Large deposits of crystallized apatite were discovered in 1927 to the east of the Murmansk railway in the Kola peninsula Arctic Russia. A sheet 45–60 metres thick extends for several kilometres across the hills Kukisvumchorr, Yukspor, Rasvumchorr, Poachvumchorr, and sixty million tons of 'ore' containing 60–80 of apatite are in sight. At the new town of Khibinogorsk 400,0 tons of apatite were produced in 1931, being separated by flotation from the 'ore'. The sheet of 'ore' is a coarse-grained aggregate apatite 85 % and nepheline and aegirine 10–15 %, with small amou

f sphene, titanomagnetite, eudialyte, eucolite, aenigmatite, astro-hyllite, &c.; and it penetrates along veins into the overlying epheline-syenite and the underlying urtite. It represents the esidual magma of the urtite intrusion. The apatite is white to pale ellow or green, and contains fluorine and cerium. The associated epheline is used in the ceramic industry and as a source of potassium nd aluminium. L. J. S.

AYEUX (Lucien). *Constitution des phosphates sénoniens de Syrie.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 1553–1555.

Phosphatic deposits occurring near Palmyra consist for the most art of calcareous fragments, some recognizably bony, others tests of adiolaria or foraminifera, but all phosphatized to a varying degree, nd embedded in calciferous material itself also more or less phospha-zed, and containing usually some quartz. The structure is rarely olitic. C. A. S.

AYEUX (Lucien). *Constitution des phosphates sénoniens de Palestine et de Transjordanie.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 1893–1896.

These deposits resemble in general those of Syria, differing there-om, however, by containing a much larger proportion of bony agments of unusual structure, so as to form almost an ossiferous icrobreccia. This is often impregnated with bitumen and much ltered. The bitumen has not extended to the foraminifera or the halky gangue. Polarized light indicates the presence of much patite. C. A. S.

AYEUX (Lucien). *Constitution des phosphates sénoniens d'Égypte.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 2134–2137.

Deposits of phosphates have been found at Safaga and Kosseir on he Red Sea, Sebaia in Upper Egypt, and in the Dakhla oasis, only he first of which is now worked. They generally resemble those of yria and Palestine, and consist mainly of an ossiferous breccia of ertebrate bones, with similar amounts of irregular or globular morphous grains of phosphate, and still less of siliceous fragments, ome undifferentiated, others tests of diatoms or radiolaria, but with o foraminifera. The gangue may be calcareous, quartzo-calcareous, ypseous, phosphatic, clayey, or absent. C. A. S.

Les ressources minérales de la France d'outre-mer. Publications du Bureau d'études géologiques et minières coloniales, Paris. Vol. 1, *Le Charbon*, 1933, 245 pp., 33 figs.

—— Vol. 2. *Le fer, le manganèse, le chrome, le nickel, l'étain, le tungstène, le graphite, le glucinium, le molybdène, le cobalt, le titane, le vanadium.* 1934, 436 pp., 59 figs.

—— Vol. 3. *Le zinc, le plomb, l'argent, le cuivre, l'or, les minerais radio-actifs, le mica, les pierres précieuses, substances diverses.* 1935, 394 pp., 5 pls., 27 text-figs. Price 40 frs.

—— Vol. 4. *Le phosphate.* 1935, 207 pp., 3 pls., 20 text-figs. Price 20 frs.

These are companion volumes and a continuation of 'La géologie et les mines de la France d'outre-mer' [M.A. **5**–273]. They contain a series of articles by different authors on the mineral resources of the French colonies. L. J. S.

Clays.

Marshall (C. E.). *Layer lattices and the base-exchange clays.* Zeits. Krist., 1935, vol. 91, pp. 433–449.

It is shown that the available chemical analyses of montmorillonite and beidellite are in agreement with a formula $Al_4(OH)_{12}Si_8O_{12}(OH)_8$, in which Si may be replaced by Al or Fe···, or 2Si by AlP, and Al may be replaced by Fe···, Fe··, Mg, Mn, or Ca, or 2Al by TiMg; any residual electrical charges on the lattice are balanced by mono- and divalent cations including H·, which are partly located within the layers of the lattice, being then non-exchangeable, and partly associated with the water molecules in the wide spaces between the layers, when they constitute the exchangeable cations. In the montmorillonites the chief replacement is Mg for Al, and in the beidellites Al for Si. Many nontronites appear to be ferruginous beidellites, but some seem to be iron-kaolinites. A series of new analyses of fractions of known particle size from three soil clays indicate that they are montmorillonites and beidellites, in some cases admixed with quartz or cristobalite, a result in agreement with the optical study. It is suggested that the aluminium liberated from the hydrogen clays by treatment with neutral salts is wholly or mainly that replacing Si in the lattice. M. H. H.

Marshall (C. E.). *The constitution of clay minerals.* Sci. Progr. London, 1936, vol. 30, pp. 422–433, 2 figs.

A review of recent optical and X-ray work on clay minerals. [M.A. 5–359, 362; **6**–132, 123, &c.] L. J. S.

Insanda (C. J.) & Barth (Tom. F. W.). *Note on the structure of dickite and other clay minerals.* Amer. Min., 1935, vol. 20, pp. 631–637, 1 fig.

Rotation and Laue photographs of single crystals of dickite from Pine Knot colliery, Schuylkill Co., Pennsylvania [M.A. **6**–137], gave 5·145, *b* 8·882, *c* 14·337 Å., β 83° 15′, in agreement with the results obtained by J. W. Gruner by the powder method [M.A. **5**–325], but the space-group is C_{2h}^6 (not C_s^4), as the crystals are not piezoelectric. Since the layer-structures of the other clay minerals were based on this they will now require revision. L. J. S.

Bojkowski (Zbigniew). *O bentonice polskim z okolic Krzemieńca.—The bentonite in Poland (in Lower Sarmatian of Krzemieniec).* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1934, vol. 10, pp. 98–114 (Polish), pp. 115–116 (English summary, 1 fig.

Bentonite forms a bed 5–20 cm. thick in sandstone over a wide area. The clay-like material is yellow with waxy lustre when dry and a soapy feel when wet. It swells quickly in water. Sp. gr. 1·076. The minute (1 μ) flakes have *n* 1·520 when dry (much lower when wet) and birefringence 0·007. Analysis of purified material gave SiO_2 48·85, TiO_2 0·66, Al_2O_3 19·04, Fe_2O_3 2·61, FeO 0·11, MnO 0·33, MgO 3·78, CaO 3·37, Na_2O 0·16, K_2O 0·21, P_2O_5 0·14, H_2O 18·39 = 100·65. These figures and the dehydration curve indicate montmorillonite. This occurrence of bentonite, derived from volcanic ash, is connected with the volcanic activity in Transylvania in late Miocene time. L. J. S.

Łamieński (Marjan). *Kilka uwag o bentonitach w Polsce.—Quelques remarques sur les bentonites en Pologne.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1935, vol. 11, pp. 113–120 (Polish), p. 121 (French résumé).

Occurrences of bentonite at Lwów [= Lemberg] and Weryń in Sortonian (Miocene) beds in Podolia are very similar to those at

Krzemieniec in Volhynia [preceding abstract]. Three analyses show ratios of $SiO_2 : Al_2O_3 : H_2O$ ranging from 4·4 : 1 : 5·2 to 4·7 : 1 : 7·4.

L. J. S.

Piotrowski (Hugo Ludwik). *O naturze chemicznej haloizytu i o alofanoidach. (Złoże alofanoidów w rudonośnym pasie jurajskim Kielecko-Radomskiego okręgu górniczego).—Sur les caractères chimiques de l'halloysite et sur les allophanes. Le gisement des allophanoïdes dans la zone minéralisée du Jurassique du district minier Kielce-Radom.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1934, vol. 10, pp. 1–86 (Polish), pp. 87–89 (French résumé), 1 pl., 28 text-figs.

Halloysite and allophane occur in pockets and veins in a clayey sandstone beneath the Callovian ferruginous sandstone of the Władsław iron (limonite) mine. I gives the range in composition shown in eight analyses of white opaque material consisting mainly of halloysite, and II of four analyses of glassy transparent allophane.

	SiO_2.	Al_2O_3.	H_2O.	$Al_2O_3 : SiO_2$.	Sp. gr.
I.	33·50–38·56	32·58—33·10	28·72—32·72	1 : 1·97—1 : 1·72	2·108—2·039
II.	24·37—28·29	35·81—36·19	35·40—38·57	1 : 1·34—1·14	2·005—1·897

Many dehydration and thermal curves are given, and the absorption of various colouring matters studied. X-ray photographs of halloysite and kaolin are identical. Halloysite is an alumino-silicic acid and not a mixture of alumina and silica hydrates. It is a hydrogeli variety of kaolin and the formula is written as $[SiO_6.SiO_2]Al_2H_2.H_2O$ $+c$ 3aq. No definite formula can be given for allophane. A biblio graphy of 122 items is added.

L. J. S.

Thugutt (Stanisław Józef). *O pewnych reakcjach kaolinu i haloizytu —Sur certaines réactions du kaolin et de l'halloysite.* Arch. Min Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1935 vol. 11, pp. 122–130 (Polish), pp. 131–133 (French résumé), 1 pl

Although kaolin and halloysite give similar X-ray patterns, an are considered to be identical [preceding abstract], yet they yiel different products when digested with HCl or with dilute solution of NaOH.

L. J. S.

Longchambon (Henri). *Sur les constituants minéralogiques essentiel des argiles, en particulier des terres à foulon.* Compt. Rend Acad. Sci. Paris, 1935, vol. 201, pp. 483–486.

Examination of numerous fuller's earths and similar clays show the presence, not of sepiolite as once thought by the author [M.A

189], but of a closely similar silicate of Al, Mg, and Fe, having same X-ray structure, but a different dehydration curve, and ich is scarcely attacked by cold HCl. Its various varieties form, th the sepiolites and palygorskites, an isomorphous series of which extreme terms are sepiolite $Si_4O_{11}Mg_3.H_2O.zH_2O$, and paramoril-ite $Si_4O_{11}Al_2.2H_2O.zH_2O$; a varying proportion of Al and Mg is placed by Fe so that some samples verge on nontronite. In addi-n to the fuller's earths and smectic clays the series includes mont-orillonite, confolensite, steargillite, saponite, &c., but differs radically m the kaolinic clays. Certain clays are included in neither group, g. the bentonites. It is suggested that the clays of the first (paly-rskite) group originate from pyroxenes and amphiboles, those of kaolin group from felspars and micas. C. A. S.

APPARENT (Jacques de). *La place de la montmorillonite dans la catégorie des silicates phylliteux.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 201, pp. 527–529.

According to recent analyses the composition of montmorillonite is pressed by $(Mg,Ca)O.Al_2O_3.5SiO_2.5–8H_2O$ [M.A. **3**–72], any defect SiO_2 on the proportion $SiO_2 : Al_2O_3 = 5 : 1$ being deemed due to presence of kaolinite. Variation in the relative amounts of g,Ca), Si, and Al may, however, be explained by equivalent re-cement of SiMg by Al_2. On the basis of X-ray results for mont-orillonite and related minerals the formula $(OH)_2Al_2Si_4O_{10}.(OH)_2+H)_6MgSiH_2$ is suggested, electrostatic attraction between the ions and OH holding together the pyrophyllite and brucite portions of e molecule. These occupy spaces otherwise unoccupied in the ystal-structure [M.A. **4**–465], and explain the presence of $6H_2O$, y excess over which amount is merely imprisoned, but not incor-rated in the crystal-structure. Changes observed in the X-ray agram on heating are in conformity with this formula.

C. A. S.

URBAIN (Pierre). *Sur la séparation des divers constituants des marnes.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 201, pp. 92–94.

The marl is disintegrated in water (5–10g./200 c.c.). The mud is tered and separated into three grades by washing on three grades sifting silk (with meshes 300, 180, and 90 μ), thus separating icroscopic particles for separate examination. The washings con-ining the finest particles and the electrolytes are electrodialysed, e carbonates being brought into solution by passing in CO_2 under

pressure. The suspensions thus separated are treated as propose by Demolon and Bastisse [M.A. **6**–134]. C. A. S.

Miscellaneous.

[Ratzbaum (E. A.) & Filippov (A. N.)] Рацбаум (Е. А.) и Филиппо (А. Н.). О химическом составе лавровита.—Filippov (A. N & Ratzbaum (E. A.). *On the chemical composition of lawrovit* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 193 vol. 2, p. 409 (Russ.), p. 410 (Engl.).

Lavrovite, a grass-green variety of diopside from Slyudyanka rive Lake Baikal, was dissolved in HF + HCl, and the spark spectru compared with standard solutions. Besides Si, Ca, Mg, there we found Cr 1·5, Al 0·7, V 0·5, Fe 0·15, Mn 0·001 %, K, Na, Ti trace The green colour is probably due to chromium, rather than to van dium as previously suggested. Heated at 500° C. the mineral b comes nearly colourless, but regains its deep green colour c cooling. L. J. S.

Alimarin (I. P.) & Arest-Yakubovich (R. E.). Алимарин (И. П.) Арест-Якубович (Р. Е.). О содержании рассеянных элементов некоторых плавиковых шпатах СССР.—Alimarin (I. P.) a Arest-Yakubowich (R. E.).—*On the content of scattered elemen in some fluorites of the USSR.* Бюлл. Московск. Общ. Испы Прир. (Bull. Soc. Naturalistes, Moscou), 1934, ser. 2, vol. 4 (Sect. Géol., vol. 12), pp. 575–583 (Russ. with Engl. summary

Micro-chemical and spectrum analysis of fluorite from Aurakhm and Abagaytuy, Siberia, showed the presence of traces of Li, Na, Sr, Be, Cu, Al, Fe, S. The Na, Cu, and Sr are assumed to repla calcium, while the remainder are present as impurities. The colou of fluorite are due to dispersed particles of metallic calcium, t particular shade depending on the degree of dispersion.

L. J. S.

Koch (G.). *Chemische und physikalisch-optische Zusammenhän innerhalb der Sprödglimmergruppe.* Chem. der Erde, 193 vol. 9, pp. 453–463, 5 figs.; Inaug.-Diss. Univ. Halle.

The following data for the 'brittle micas' were determined pure material carefully separated by the centrifuge method and Clerici solution. Other data from the literature are tabulated a results plotted to show the variation of the optical properties wi

e chemical composition. In margarite ($H_2CaAl_4Si_2O_{12}$) with re-acement of Ca by Na_2 there is a linear decrease in the refractive dices and optic axial angle and an increase in the birefringence. e richest in soda is the soda-margarite from Postmasburg, South rica [Min. Mag. **22**–482]. Clintonite (including xanthophyllite d brandisite) has the formula $H_2CaMg_3Al_2Si_2O_{12}$, equivalent to that margarite with Mg replacing some Al. Formula of chloritoid (anal.) $H_8[Si_4Al_4]Al_4Fe_4O_{28}$, and of ottrelite (X) $H_8[Si_6Al_2]Al_4Fe_3O_{28}$. ragonite (which has sometimes been placed in the 'brittle mica' oup and thought to contain admixed quartz and muscovite) gave al. XI, formula $H_2NaAl_3Si_3O_{12}$, proving it to belong to the mica oup.

		Sp. gr.	α.	β.	γ.	2E.
I.	Margarite, Chester, Mass.	—	1·638	1·648	1·650	82°26′
II.	,, Unionville, Pa.	—	1·636	1·646	1·648	80 7
III.	,, Pennsylvania	—	1·634	1·644	1·646	79 39
IV.	,, Zillerthal	—	1·630	1·642	1·644	74 46
V.	Clintonite, Ural	3·071	1·648	1·659	1·660	55 59
VI.	,, Ural	3·062	1·648	1·659	1·660	55 48
II.	,, (green) Monzoni	3·084	1·648	1·659	1·660	55 56
III.	,, (red) Monzoni	3·015	1·582	1·608	1·610	50 7
IX.	Chloritoid, Rhode Island	3·516	1·730	1·734	1·740	—
X.	,, Ottrez	3·318	1·716	1·718	1·724	—
XI.	Paragonite	2·852	1·577	1·599	1·605	—

V, from Shishim; VI, from Nicolaye-Maximilanovsk, Ural.

	SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.	Na_2O.	K_2O.	HO_2.	Total.
I.	29·57	49·97	2·94	—	0·22	0·34	10·89	0·92	—	4·81	100·05
II.	31·98	49·21	—	0·79	—	0·76	10·64	1·53	0·21	4·95	100·07
III.	30·84	50·76	0·12	0·35	0·11	0·35	10·52	1·68	0·32	4·97	100·25
IV.	29·78	50·94	1·13	—	—	0·66	10·21	2·21	0·50	4·77	100·20
V.	17·02	43·02	1·07	0·60	—	20·64	13·12	—	—	4·81	100·28
VI.	17·15	42·21	1·39	0·63	—	20·93	13·14	—	—	4·77	100·22
II.	18·34	40·69	2·04	1·12	—	20·53	13·04	—	—	4·71	100·47
III.	18·29	40·42	0·34	2·56	—	20·81	10·96	1·78	0·36	4·62	100·14
IX.	24·98	35·07	4·81	26·84	0·79	0·67	0·58	—	—	6·34	100·08
X.	39·40	29·61	4·43	15·36	3·67	1·71	0·12	—	—	5·86	100·16
XI.	44·38	44·72	0·41	—	—	0·36	—	5·47	0·46	4·38	100·18

I, also Li_2O 0·39; III, also Li_2O 0·23; I–XI, material dried at 110° C.

L. J. S.

RILL (E.). *I minerali del granito di Baveno. La fayalite.* Periodico Min. Roma, 1935, vol. 6, pp. 129–133.

Nut-like nodules of fayalite enclosed in the granite are in part idized to magnetite. Two analyses by G. Pagliani gave SiO_2

28·86 (28·70), Fe_2O_3 32·51 (18·84), FeO 34·54 (46·79), MnO 3·15 (3·60), MgO 0·09 (0·12), CaO 0·41 (0·59), H_2O 1·20 (1·19), total 100·76 (99·83). The freshest material has sp. gr. 4·22. L. J. S.

THUGUTT (Stanisław Józef). *Produkty hydrolizy labradoru wołyńskiego z Horoszek* wraz z *badaniami rentgenologicznemi* Dr. Marj. KOŁACZKOWSKIEJ.—*Sur les produits d'hydrolyse du labrador volhynien de Horoszki* avec une *étude au moyen de rayons X* par Mlle Marie KOŁACZKOWSKA. Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1935, vol. 11, pp. 13–19 (Polish), pp. 20–23 (French résumé).

Labradorite from Horoszki, Volhynia, (anal. I) was finely powdered and spread on platinum plates, and heated in a closed tube with water for 103 hours at 233–238° C. Analysis II is of the portion (6 %) that passed into solution and III of the residue. The final residue is amorphous, but intermediate fractions on the platinum plates still showed the X-ray pattern of labradorite. With albite and orthoclase 40 % and 20 % respectively passed into solution.

	SiO_2.	Al_2O_3.	Fe_2O_3.	MnO.	CaO.	Na_2O.	K_2O.	H_2O.	Total.
I.	55·60	27·96	0·24	0·18	10·28	5·25	0·71	0·24	100·46
II.	72·36		0·57		4·29	4·46	0·17	8·15	100·00
III.	50·80	31·71	0·71	0·41	7·57	5·70	0·82	2·28	100·00

L. J. S.

THUGUTT (Stanisław Józef). *O produktach przeobrażeń leucytu skałowórczego.—Sur les produits de décomposition de l'amphigène.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1935, vol. 11, pp. 141–146 (Polish), pp. 147–149 (French résumé).

Leucite from Rome (anal. I, sp. gr. 2·48) when digested with pure water in an autoclave for 103 hours at 182–220° C. gave an opalescent solution (anal. II) containing 45·3 % of the material. The insoluble residue gave anal. III.

	SiO_2.	Al_2O_3.	Fe_2O_3.	Na_2O.	K_2O.	H_2O.	Total.
I.	54·46	22·65	1·52	0·83	20·25	0·14	99·85
II.	47·25	19·17	0·33	0·65	17·39	15·20	99·99
III.	53·59	23·78	0·70	0·66	19·58	1·59	99·90

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